THE

# ELECTRICAL REVIEW.

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## ELECTRICITY AND THE MEDICAL PROFESSION.

THERE is probably no branch of medical science which is so little understood by practitioners as that which involves the use of electricity for curative purposes. To an expert in electrical science the extraordinary ignorance which is displayed, even by those who are of acknowledged standing in the medical profession, is a matter for wonderment, and it to a great extent inclines to make one lose faith in the reliability of the profession generally. It is a not uncommon retort when the question is discussed, for the medical gentleman to say, "You may know something about electricity, but you have never studied medicine, and therefore what can you know about the application of electricity to medical purposes." This retort would be a just one were the electrical expert to claim that he knew how electricity should be applied for the purpose, but he claims no such thing; he simply asserts "you state that an electrical appliance produces an electrical current in a particular manner, when it is perfectly certain that it cannot do this, for the laws of electricity are perfectly definite, and these laws distinctly prove that a current cannot be so produced." We might say a great deal also about the cunning verbiage which reads like the assertion of mighty truths. We are but human, and when ailing, most of us are apt to jump at anything which seems likely to afford relief, without being able to exert our reasoning powers which, in time of full health and consequent mental activity, would show the probable, if not certain, absurdity of the claims set forward by the purveyor of the so-called cure. To show want of sympathy with the really suffering brands a man as unfeeling, to take advantage of that helplessness to wring money from the sufferer stamps the man as a being beneath contempt; yet of such a class are the men who fatten by the sale of useless electrical appliances, and who should be effaced by the strong arm of the law.

Much help towards exposing and rendering nugatory the efforts which are daily made to promote the sale of the wares to which we refer, might be given by those in authority in the medical profession if they would signify in some definite way their sense of the conduct of those who in any way ally themselves with the promoters of such electrical appliances; but no sign is visible, so once again we are compelled to take up the cudgels on behalf of the public, this time at the direct invitation of the President of the Electropathic and Zander Institute himself. To come to the point, we have now before us a pamphlet on "The Treatment of Disease by the Prolonged Application of Currents of Electricity of Low Power," by Dr. H. Tibbits, which we consider to be a grave reflection upon the intelligence of the medical profession generally, seeing that Dr. Tibbits is, we believe, supposed to be a recognised

authority in the medical world; the pamphlet is nothing more nor less than a direct recognition by Dr. Tibbits of the Harness "Electropathic Belt" as a valuable electro-medical appliance. In the light of the trial in the Bloomsbury County Court, which we reported in our issue of July 22nd, and in which it was brought out that one of Mr. Harness's qualified medical officers who dealt with cases of hernia was originally a "furniture salesman," the reference to the "qualified officers" in the following extract from a letter to Mr. C. B. Harness should be noted. The extract is as follows:—

The West End School of Massage and Electricity
(Established 1886), London, W.

*August 24th*, 1892.

I have pleasure in handing you an extract from my book upon "Massage, Electricity, and Allied Methods of Treatment," as to the value of mild currents of electricity in the treatment of disease.

When I first asked you for the "Electropathic Belts" to experiment with, I did so with considerable doubt as to their generating electricity; but I am pleased to say that my investigations and experiments have most conclusively proved that they *do* generate it.

Now that I have been able to scrutinise every department in your establishment, I desire to congratulate you upon the very efficient machinery and instruments you possess; and having, during my inspection, been brought into contact with several of your qualified officers and nurses, I can testify to the great value of your institute to members of the medical profession who have cases suitable for treatment by electricity and mechanical exercises, as it is impossible for a private practitioner to ever hope to have the resources such an institute as yours commands.

I was also glad to see cases presented for treatment, diagnosed by your legally qualified medical assistants, and that strict clinical records were kept of the progress made, for it is only by practice and daily observation that electro-therapeutists can gain the necessary knowledge and experience.

Yours faithfully,

HERBERT TIBBITS, M.D., F.R.C.P. Edin., &c.

As is usual in letters of the kind, there is one thing that is true in what is said, and this acts as a gloss to make to appear to be true what is certainly, but not distinctly, false. The second paragraph, for example, literally speaking, asserts a fact which has never been seriously doubted, *i.e.*, that the Harness belts when connected up *do* generate infinitesimal quantities of electricity, just in the same manner as does the old schoolboy experiment of placing a piece of zinc upon the tongue and a penny underneath and then bringing their projecting edges into contact. No doubt "it is impossible for a private practitioner to ever hope to have resources such an institute as yours commands;" we admit that as the result of money accumulated by the sales of a great number of useless appliances an "Institute" has been founded, which may contain resources which, if honestly made use of, would be of real value, but there is clear evidence, we think, that the latter is not the object in view; the real object is to gild the counterfeit and make it appear to be all of sterling gold. Coming now to Dr. Tibbits's experiments on the Harness belts, we have the following:—

1. Does the apparatus generate electricity?

2. If electricity be generated, does that electricity penetrate the skin (which we know is, at any rate, not a *good* conductor) and influence subjacent organs, muscles, nerves, &c., or does the electricity, as has been contended by *unskilled persons circulate over or across the skin*, and simply return to the battery without any effect upon the patient?

These are questions which must be determined not by the effect of the appliance upon the patient, not by theoretical considerations, *but by the test of scientific instruments of precision*, and quite irrespective of any claims advanced by the manufacturers or vendors.

I have tested many advertised appliances, and without entering into a long dissertation upon the relative efficiency of these, I have no hesitation in saying that regarded from *a strictly scientific point of view*, the electropathic appliances manufactured by the Electropathic and Zander Institute, who are manufacturers of Mr. C. B. Harness's various patents, 52, Oxford Street, London, *are preferable to any others*. By the courtesy of Mr. Harness, I have been permitted to test all his electrical appliances, and I give the result of my investigations. These appliances are *scientifically constructed*, perfectly manufactured, and admit of being placed upon and kept in close contact with the skin, or with any part of the body.

They consist of six or seven different arrangements, each arrangement consisting of a series of twelve pairs of elements (of which a greater or less series can be used).

(*a.*) The couples are isolated.

(*b.*) Four separate batteries of three couples each are connected as directed.

(*c.*) Two batteries of twelve couples are connected as desired.

(*d*) The twelve couples are connected as one or two cells as required.

(*e.*) The twelve couples are connected in parallel as one cell.

(*f.*) This belt is a variation of preceding.

It will thus be seen that *either quantity or intensity*, can be obtained.

With the above apparatus I conducted the following experiments:—

1. Slightly moistened, all the above gave considerable deflections of a milliampère galvanometer.

2. When worn upon the body, and set in action by the natural perspiration, the wires from the poles being connected with a galvanometer, gave deflections.

3. The apparatus being worn upon the body, the positive pole was connected with Lord Kelvin's reflecting galvanometer, and a platinum needle, insulated to within $\frac{1}{16}$th of an inch of its point, and also connected with the galvanometer, was inserted $\frac{1}{4}$rd of an inch perpendicularly through the skin, and one inch from the negative pole, the distance between the two poles being 6 inches; and the intervening skin being thoroughly dry, *and powdered with starch powder, so as to render it as much of an insulator as possible.* The beam of light at once travelled several degrees. The needle was then re-inserted exactly midway between the two poles, and a smaller deflection was obtained.

These experiments prove conclusively that a current of electricity penetrated the skin, and influenced the subjacent tissues.

The dosage of electricity has not yet been scientifically determined, and the question with regard to the dosage of these weak and long-continued currents must stand the test of experience; but I claim to have settled that, as above stated, currents do enter into and circulate in the body when carefully applied by means of such efficient apparatus.

There is no doubt that the *weak electrical current* has been of singular service in many and varied forms of disease; so that we are bound to give great credit to the value of these "mild currents," no matter how generated.

As I have aforetime failed to acknowledge this, I have pleasure in writing that I had, perhaps, not sufficiently investigated the matter, because scientific instruments of precision were not always at my hand.

*These experiments can, of course, be repeated by any scientist, and in making them I was influenced by a conviction that the time had fully come when it would seem to be absolutely necessary that some such investigation should be carefully conducted by a practised electro-therapeutist.*

In carrying out the foregoing experiments upon different subjects, I became thoroughly convinced that the continuous current generated by Mr. Harness's electropathic appliances, not only overcame the skin's resistance, which had been settled long ago by eminent scientists, but that the appliances themselves were valuable and very convenient for self-application.

A perusal of the foregoing by any one who has a very elementary knowledge of galvanic electricity, and who has one of the Harness belts before him, will at once show that the writer exhibits a most incredible ignorance of electrical laws, an ignorance which utterly unfits him to speak as an authority, and which in view of the support which it affords for the bolstering up of this appliance, seems to call for an interdiction by the British Medical Association. To go into all the points is unnecessary, we will simply refer to one or two. It is stated: "It will thus be seen that *either quantity or intensity* can be obtained." To this assertion we give a point blank denial; the discs cannot be joined up for intensity and we wonder whether any elementary student would make the ridiculous assertion that a number of couples immersed in an electrolyte, contained in *one* vessel, would give more than the electromotive force of one couple.

Everybody knows, or is supposed to know, that muscles, tissue, blood vessels, &c., are comparatively good conductors compared with the epidermis, but the discs on a Harness belt are not furnished with platinum needle points one-third of an inch long, for the purpose of puncturing through the skin, and thus, in a mechanical way, getting over its highly resisting properties. Surely such a subterfuge is too transparent to deceive anybody of ordinary intellect, but we think it incumbent upon the editors, considering the powerful influence exerted by such serials as the *Lancet* and the *British Medical Journal*, that they should bring this latest phase of the electropathic belt business before their readers.

All electricians conversant with the extraordinary sensitiveness of the Lord Kelvin—or as we prefer to have it—the Thomson reflecting galvanometer, are perfectly aware that *several degrees* mean *practically* no current. A piece of zinc and a platinum needle will produce all the effects stated above without the intervention of the belt worn upon the body; indeed, in the absence of any indication that the negative pole of the belt was connected to anything at all, it appears perfectly evident that the belt, *per se*, played no part in this little "comedy of errors."

What value, we would ask, is the bare statement that "a deflection is obtained on *a* galvanometer?" The introduction of the term "*Lord Kelvin* reflecting galvanometer" is a pretty transparent device; the public will at once say, "Oh! if we get evidence of an electric current on a *Lord Kelvin* instrument, of course the appliance producing the current must be a most valuable contrivance, and cheap at several guineas." Such is the public logic (?) and, unfortunately, those who trade thereupon know it. With all the rubbish (to call it by a mild term) written, the concluding paragraph follows as a matter of course.

To get at the public, so as to protect them, is most difficult; the *Daily Press* is, unfortunately, too interested from an advertisement point of view, to enter into the matter. We are pleased, however, to note that *Science Siftings* has entered the arena to do battle against this imposture. We heartily wish it success, and although it may take time, we feel little doubt but that perseverance will eventually command it, and that what is, undoubtedly, a grave scandal, may at last be unveiled in all its grossness, and the promoters and abettors brought to book.

## ALTERNATING CURRENT WORKING.

CONSIDERABLE obscurity still surrounds the working of alternators, transformers and alternating motors. A writer in *Industries* attributes much of this obscurity to the unfortunate fact that alternating currents have been so suitable for mathematical treatment, and that although a vast amount of work of this class has been done, it leaves us very much in the dark as to the proper design, construction, or working out of alternating current machinery. It has always been thus in electrical engineering. The continuous current dynamo went through the same unfortunate stages, volumes were filled with the theory of the dynamo treated in the most elaborate mathematical methods, yet all the while they were building dynamos with ridiculous magnets, designed without the slightest regard to the idea of a magnetic circuit, and the magnets were supposed to act on the armature inversely as the square of the distance; and the mathematicians arrived at an equation which gave $E = 4\,n\,A\,H$, in which $n$ is number of revolutions, A an "effective area" of the armature coils, H intensity of field. This formulæ was utterly useless for any practical purposes. Engineers, however, finally arrived at the idea of the magnetic circuit, and very soon got at the root of the theory of dynamo machine construction based on the thoroughly practical and useful equation, that $E = n \cdot C \cdot N \cdot n$ = revolutions, C armature conductors, N total magnetic flux through armature; all of which are quantities easily understood and arrived at; and so, out of the chaos into which the continuous current dynamo fell at its birth, it has been raised into a most orderly and systematically treated subject.

Alternating current dynamos have been treated at great length mathematically, yet they are not in the same satisfactory position in regard to their design, and our knowledge of their actions and interactions; they have, of course, benefitted largely by our knowledge and experience gained in building continuous current dynamos. We can apply the magnetic circuit theory in their design, and also the armature reaction theory, and, so far, alternators have been much improved of late, but the actions and effects peculiar to alternators are still obscure. The parts played by self-induction, lag of C behind E in the armature coils, and impedance, are all very elaborately traced out mathematically, but nobody seems able to give us any account of their actual effects in practice.

The special difficulties referred to in the article in *Industries* are those in the way of working alternators in parallel.

We may say at once, that any number of alternators can be run in parallel as motors from a sufficiently powerful generating alternator; that, however, is not a solution of the problems arising when we wish to run any number of alternators as generators feeding into the same mains; in the case of motors, the synchronism required is totally different from that required by generators; the motors must synchronise but not co-phasedly with the generator; generators must run co-phasedly synchronous with each other when feeding into the same mains. Few people, even electrical engineers, can realise what nicety and exactness is meant when we say that two machines running out a current at 100 ∿ per second can be run co-phasedly synchronous.

And, in point of fact, in practice, exact co-phased parallel running of alternators is seldom attained, consequently some of the alternators are always doing more than their share of the work, while others are doing less. Of course, the magnetic and electrical disturbances set up in the alternators all tend to maintain co-phased synchronism, and to bring them back into step again, but the time allowed to accomplish this is exceedingly small—perhaps during a thousandth of a second in each period. Slow frequency machines act better in this respect, because there is more time allowed for the magnetic and electric forces to act towards bringing the out-of-step machines into step again, and slight difference of phase is not so serious as it is in high frequency machines. The engines driving the alternators require the strictest investigation, both in regard to the system of governing on them, and especially in respect to their absolutely steady running. The slightest stagger in the re-

volution of the engine throws the alternator out of phase to some extent; in fact, it is, perhaps, expecting too much to look for an engine steady enough to maintain constant co-phased synchronism.

It must be remembered that alternators may run on, apparently, in parallel all right, and some of them may be out of phase sufficiently to cause serious loss of power. Every alternator should, therefore, be fitted with a means of indicating whether it is in or out of phase, and approximately how much it differs.

It may be possible, by improvements on alternators, to so strengthen the controlling forces which tend to maintain co-phased synchronism, that they would instantly correct any deviations. With this in view, the study of the effects of self-induction, lag, and impedance is of importance.

It is of importance to note that these three quantities are smallest when alternators are built on the same lines as continuous current dynamos, that is, when the E.M.F. is produced by making a very powerful field act on an armature, having few armature conductors in its coil, fundamentally $E = n \cdot C \cdot N$. in an alternator, just as in a continuous dynamo, so that in designing alternators, we must obtain the necessary E by making C as small as possible, and N as large as possible. This is carried out as far as is possible in all good alternators of recent design.

Machines designed on these lines do run better in parallel than did the older machines, designed without regard to a magnetic circuit. By building machines for alternating current work on exactly the same principal fundamental rules, we must come nearer perfection.

Compound winding of alternators might remove one of the difficulties in running them in parallel, as it removes the necessity for continually watching the exciting currents in the dynamo field magnets.

It must not be concluded from all this that running alternators in parallel is not practised. We are aware that it is quite common; but machines may run in parallel, and not be working economically, owing to the slight differences of phase, due to almost imperceptible variations in the engine revolution, and the want of sufficiently powerful controlling forces in the alternators themselves.

## THE FREQUENCY OF ALTERNATING CURRENTS.

THE frequency of an alternating current must have an important effect upon all devices into which it is circulated.

M. Tesla has made a great deal of high frequency, but without much effect in ordinary engineering practice.

Low frequency has been recently discussed by Prof. George Forbes, and advocated by him as a solution of the tramway and railway electro-motor question.

The frequency at which alternating currents should be used depends on the purpose to which it is to be put; it is therefore impossible to say what frequency is best, except we might say that that frequency which is serviceable to the greatest number is the best.

For general distribution of electricity in towns a moderate frequency, not less than 60 to 70 ∿ per second is necessary, because with less than that the flickering of the light, even although imperceptible, is dangerous to the eyesight; and if the distribution of alternating currents is a house-to-house one with many small transformers, then high frequency is necessary, from 120 to 200 ∿ being common practice in this case, which is a common one in America. In that country the house-to-house system prevails. With high frequency the transformers are small and cheap, so that high frequency saves money in first cost where transformers are numerous.

In this country, where towns are more crowded as a rule, the sub-station plan, using large transformers, is the best one under the conditions; large transformers work better with low frequency, the limit being 60 to 70 for the sake of the eyesight, as already mentioned.

In transmitting power by alternating currents, there is no limit fixed such as that for lighting; here the frequency must be low, so that the impedance of the exciting coils on motors may be as low as possible. Multiphase motors, and other motors for alternating currents, have their field magnets excited by the alternating current. If the frequency is low, the impedance is low; hence the excitement is produced at a low pressure. In every case of transmission of power the problem is a special one, and the engineer will generally fix upon a frequency to suit the motors he intends to put in.

Low frequency is not of much advantage for synchronising motors wherein the magnets are excited by a local battery or exciter; but high frequency synchronising motors are much easier pulled out of step than a lower frequency motor.

The resistance of the mains is great with high frequency, so that more copper has to be used, or a greater loss allowed for, than with low frequency; so that, on the whole, low frequency seems to have the advantage in every case except that of house-to-house transformer distribution, and that is a system not now followed in this country.

But extremely low frequency can be used only for power transmission, or for feeders on a multiphase system where no lighting is to be carried on by the alternating current direct.

**Magnetism and Atomic Weight.**

IN a paper contributed (about a year ago) to the *Berichte*, (Vol. xxiv., pp. 88, 89), L. Errera maintained the impossibility in the present state of our knowledge, of establishing any more definite relation between the magnetism and the atomic weights of the elements than that which he pointed out some time ago, namely, that the elements in the odd series in Mendeléeff's table are diamagnetic, and those in the even series paramagnetic. He also criticised rather severely a paper in the *Journal of the Russian Chemical Society* (*vide* Vol. for 1889, p. 39), in which P. Bachmetéeff discussed the relation between the magnetic properties of the elements and their atomic weights and claimed to point out several errors in the latter's reasoning. Bachmetéeff has now replied in a paper which is published in the *Berichte*, Vol. xxv., pp. 566—569. He points out that a considerable number of the elements do not obey Errera's rule, and that many of the elements now supposed to be paramagnetic are probably in reality diamagnetic, the observed paramagnetism being due to the presence of small quantities of iron. For example, platinum as a rule contains traces of this metal, and exhibits paramagnetic properties, whilst when it is obtained in the chemically pure state it is diamagnetic. There seem to be at least eight elements which behave as exceptions to Errera's rule, whereas it is pointed out that there is no known exception to the rule proposed by Bachmetéeff, who therefore considers that his deductions must be regarded as the more trustworthy.

## AN IMPROVED DYNAMOMETER.

THE *Electrical World* describes a dynamometer, with which many tests were made last year at the Frankfort Electrical Exhibition, and which is claimed to be exceedingly reliable and sensitive. This dynamometer, the invention of Mr. Fischinger, is one of the double pulley type, wherein two pulleys intervene between the power and the weight, the only connection between the two pulleys, which are free upon the same shaft, being a system of levers through which all power must pass, and the tendency of the levers to move is conveyed to a rod which lies within the hollow shaft carrying the pulleys, and this rod presses against an external system of levers which can be loaded at a scale pan, and the force acting through the mechanism thereby measured. The accompanying figures show the mechanism which is thus described.

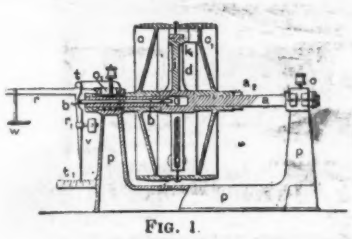


FIG. 1.

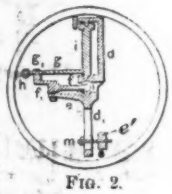


FIG. 2.

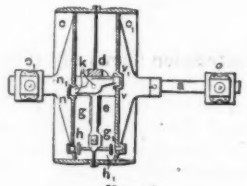


FIG. 3.

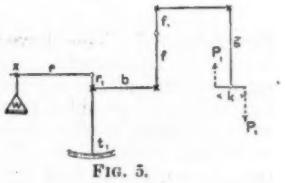


FIG. 5.

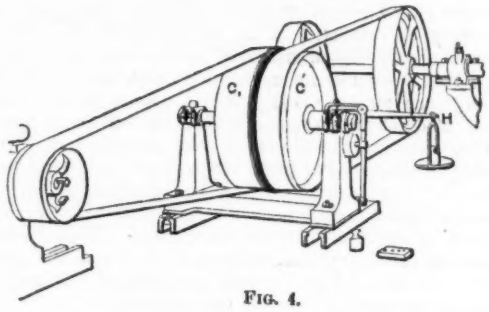


FIG. 4.

A continuous, partly hollow shaft, *a* (fig. 1), runs in the journals, $o$, $o_1$ (figs. 1, 2 and 3), of the frame, *p*. Fig. 4 gives a general view of the apparatus. The three arms, $d$, $d_1$, $e$, form one piece with the shaft, and stand out from it at right angles. The smaller shaft, *i*, with the lever arm, *g*, has its one bearing in the enlarged portion of the main shaft, its upper end running on a pin of the arm, *d*. This upper end of the shaft, *i*, carries a lever of the first class, *k*. The two arms of the latter engage with two projections, $n$, $n_1$, and $v$, $v_1$, cast on the inside faces of the pulleys, *c* and *c* (fig. 3). On a pin at the extreme end of arm, *e*, turns the double lever, *f*, *f*. A pin at the end of arm, *f*, runs in a slot, $g_1$, of the lever arm, *g*. The outer end of this arm, *g*, carries two threaded pins with adjusting nuts, *h*, *h*. To avoid sudden shocks when the dynamometer is set in motion, these two adjusting nuts strike against two rubber cushions on the inside faces of the two pulleys. The arm, *d*, has a long slot in which runs the bolt, *m*, carrying a weight, *e'*.

By a proper adjustment of this weight the centre of gravity of the whole lever system can be brought into coincidence with the centre of the main shaft, *a*, *a*.

A rod, *b*, runs through the centre of the hollow part of shaft, *a*. This rod, *b*, pushes with one end against the end of lever arm, *f*, while the other end touches the arm, *r*, of lever, *r*, *r*. An adjustable weight, *v*, serves to balance the weight of arm, *r*. The lever, *r*, *r*, turns around the pin, *t*; the arm, *r*, which ends in a sharp point, can move over a scale, *t*, at the lower end of the frame.

The action is as follows: The power is transmitted from the generator by a belt to the pulley, $c_1$, by means of the lever, *k*, *k* (fig. 1—3), to the pulley, *c*, and from this pulley by another belt to the machine under test. The rotary motion is therefore transmitted from one pulley to the other by the lever, *k*, *k*, and shaft, *i* (figs. 2, 3). But since the two pulleys are loose on the shaft they will tend to shift their position relatively to each other. This amount of shifting is communicated by the lever, *k*, *k*, to shaft and lever arm, $g_1$, thence to the double lever, *f*, $f_1$. The end of lever, *f*, $f_1$, pushes against the rod, *b*, and this in turn against arm, $r_1$, of lever, *r*, $r_1$. The tendency to shift between the two pulleys is therefore indicated by the index, $f_1$, on the scale, $t_1$ (fig. 5).

Attention is given to the internal friction of the machine by the employment of knife-edge bearings where possible, but there is unavoidably more or less resistance in all such dynamometers at the connections of the different levers which necessarily must tell upon the reading of the machine, though it is possible that this internal resistance will bear a fairly constant ratio to the force passing, and this ratio once known can be allowed for. Still, there is much to be said against the type of lever dynamometer as well as in its favour, for it is, or may be, applied readily. The trouble with all these weighing machines, for this is what they really are, is that the whole power passes through the indicator gear, much as though the power of a steam engine were to be obtained by an indicator, of which the piston or connecting rod formed a working portion, and such devices bear somewhat the nature of that class of engine governor which have to resist or transmit the power which actuates the very valve which the governor is placed to control and in which there is a constant struggle between the governor trying to do its duty and the resistance of the valve gear against change or a tendency of it to change when not desirable that it should do so. Similarly the static friction of a transmission dynamometer may be sufficient to hold its parts in a position different from what they would assume if friction could be entirely eliminated. To what extent the effects of friction are eliminated by the vibration set up by the mere act of working is more or less problematical, and it is doubtful if frictional effects will be entirely abolished in this way, and so we are inclined to very carefully avoid placing undue credence in any dynamometer not thoroughly tested by long practice.

## PLANTS IN POWER STATIONS.

MR LEE CHURCH objects to our criticism of his remarks in the New York *Electrical Engineer*, but we fancy he has not understood them exactly as we intended them to be construed, and he now states that the non-condensing engine will cover its entire range of power at an expenditure of steam lying between 23 and 29 lbs., the latter for light loads. This latter figure, after all, is an addition of 30 per cent. to the economical load consumption, and if this is the best that can be secured with a light load, we take it that, as the engine friction is so much larger a proportion of the total indicated power when lightly than when heavily loaded, the figures advanced by Mr. Church are, after all, of very little moment. Now, Mr. Church promised, after he had ably shown the wastefulness of present methods, to describe some system of engine construction or working which would give equally good results for all loads. We have possibly missed his communication wherein he shows this, for we have, so far, failed to find any thing from his pen which bears this out.

As regards his iteration about 60 H.P. boilers being sufficient for a generator of 100 H.P. maximum, we fully admitted this, though Mr. Church now appears to state that we entirely misunderstood the matter. Indeed, could anything be plainer than our remarks, reprinted at the head of page 175 of the same issue, which contains his reply. Mr. Church confesses to have for years laboured under this very common misconception as to boiler capacity, but to have now freed himself from the thraldom. As regards the condenser, when present, Mr. Church is, of

course, free of his opinions, but we cannot help remarking that it seems curious to see him first crying against too big an engine and then throwing in a whole condenser and air pump.

However, we must not take Mr. Church's reply too much to heart, for when we speak of carrying steam full stroke in the cylinders, he adds a (?) after the *stroke*, as though he would say he had caught us napping. The term *full stroke* applied to the working of steam in a practical steam engine means, as Mr. Church should know, that the cut-off valve is inoperative, and steam is cut off by the main valve; that the link of the locomotive is in full gear, and steam is carried $\frac{4}{5}$ths or $\frac{3}{4}$ths the cylinder, or even $\frac{1}{2}$ths or more in America. The term is technical, and we are surprised Mr. Church deems his (?) necessary.

We referred to what we stated would be a difficult mechanical problem, viz., to cause an engine to run faster and yet to drive its load at a uniform speed. Here we left the matter, but Mr. Church takes even the suggestion as an indication of our ignorance of steam engine art, and seems absolutely floored at a suggestion which he says would beat even Yankee ingenuity to solve. This parade of Yankee ingenuity is charming. The generous assumption that, what could not thereby be solved is hopeless of solution, is so altogether Yankee, that we may leave the subject right here, merely reminding Mr. Church of his promise which is yet unfulfilled, of showing how or what engine will fill the part he claimed for it.

If Mr. Church means the variation he now admits of from 23 lbs. to 29 lbs., we need not ask more, but this is not the solution to which his earlier remarks appeared to be leading up, and to which even now he appears to refer when he speaks of our need for instruction. We are always freely open to instruction, but we don't want our book of instruction to be all preface, and so far this is all Mr. Church has yet vouchsafed to afford. We are thus entirely at one with him in thinking it more sensible "to go direct to the point desired." So far, his going has been anything but direct, and his preface too much of the "gentle reader" type of half a century ago, or more. Mr. Church has promised so much that we feel to be in the position of the farmer with the liqueur glass of chartreuse who, having thus sampled, called forth, "Bring me some of that in a jug."

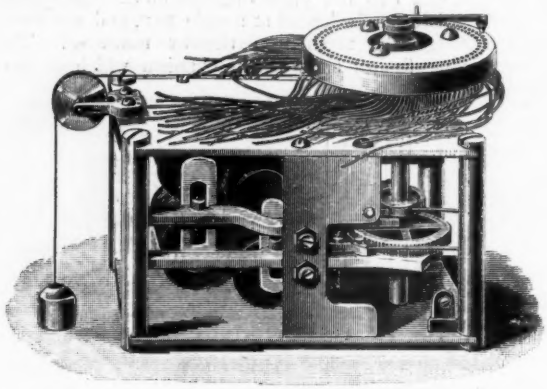
## THE STROWGER AUTOMATIC TELPHONE EXCHANGE.*

THIS is a device to automatically make the connections in a central or sub-station and to dispense entirely with the services of any *employé* at that place.

On the telephone shelf is a row of keys, five in all, marked thousands, hundreds, tens, units, the fifth being a release key. The subscriber who wishes to place himself in communication with someone of the other hundred or thousand subscribers, taps out the desired number on the keyboard, which automatically connects his wire with that of the person with whom he wishes to speak. Suppose, for instance, that a subscriber wishes to communicate with No. 1,123. He simply presses the key marked thousands once, the key marked hundreds once, the key marked tens twice, and finally the key marked units three times. His wire is then in electrical contact with that of subscriber 1,123.

The whole mechanism of the Strowger patent (as shown in the illustration) takes up a space of only 6 × 4 × 4 inches. The mechanism at the central station consists chiefly of a circular disc constructed of hard rubber, or any other suitable non-conducting material, and this is the central feature of the machine. This disc is provided with perforations in circular rows of 100 each, these rows being about one-twentieth of an inch apart. Through these perforations extend the wire connections to the main line wires, so that the wire of every subscriber in the exchange comes to this instrument, and passes up through one of the perforations, ending in a good metallic contact slightly raised above the face of the disc. If now a moving arm or needle can automatically be made to make contact with any one of these points at will, it is evident that a telephone circuit can be completed and the object of the invention attained. This is accomplished in the following manner :—

A circuit-closing arm is made in parts, of which one is a circuit-closing sleeve, firmly attached to the lower end of a sleeve-rod. Within the circuit-closing sleeve is closely fitted a circuit-closing needle held in such a manner as to be in perfect electrical contact with the wire terminal by a spring. A rod is located along the axis of the cylinder, and is free to rotate and move longitudinally. The lower end of this rod is sleeved, and into this is inserted the upper portion of



the ratchet rod. This sleeve construction allows the ratchet rod to have a longitudinal motion only, thereby keeping the ratchet teeth continuously toward the attendant pawl. The ratchet rod is provided outside of the cylinder and conveniently below it with a series of ratchet teeth, by means of which the rods are moved longitudinally. Two wheels, through which the rods extend with a feather and groove connection, are made in contact with the ratchet teeth and levers having pawls pivoted in their ends. Each lever has a vibratory movement, and is oscillated by the alternate energising and de-energising of an electro-magnet, thereby imparting motion to its adjacent ratchet teeth, and consequently the circuit closing needle. Each pressure of the push button at the exchange, made at the will of the operator, causes, through the channels thus described, the circuit closing needle to move from row to row and from wire to wire, it being understood that both ends of the wire are grounded or connected with a return tap, and also that a battery is used to generate the current. This battery is located at the sub-station, between the key and the ground. Each perforation of the cylinder is numbered with respect to an initial or starting point on the cylinder.

When any supposed conversation is ended the person hangs up his ear phone and presses the release key. This causes the magnets to be energised, attracting the armatures, thereby withdrawing the several pawls from their engagement with the ratchet teeth, and allowing the circuit closer to fall and return to its initial point.

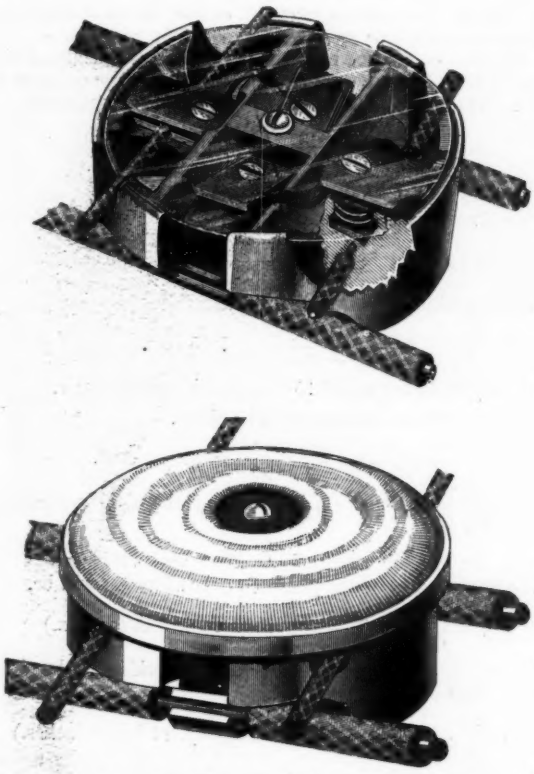
The subscriber is never isolated from the exchange. Suppose that two persons are in communication with each other, and a third wishes to speak with the first. He can tap up this number and make sufficient connection to ring his bell and call his attention to the fact that some one wishes to speak to him, so that the first subscriber can then at will release his instrument from the one with which he is in connection and connect with the third man, or he can continue his own conversation until finished, when, upon pressing the release key, he will find himself in communication with the third person. The outside party, however, cannot either speak with the other party or listen to any of the conversation; he can only obtain sufficient connection to ring his bell.

* *Electrical World* New York.

**M. G. Planté's Donation.**—A sum of 1,500 francs was left by M. G. Planté to be given as a prize to the person that should make an important advance in electrical science. After waiting several years, the Academy has accepted M. G. Planté's legacy.

## THE PASS AND SEYMOUR BRANCH BLOCK.*

THE accompanying illustrations show clearly the construction of the china branch block introduced by Messrs. Pass & Seymour, of Syracuse, N.Y. It is very neat in appearance, and is claimed to entirely overcome any danger of the blowing of



FIGS. 1 AND 2.—PASS AND SEYMOUR BRANCH BLOCK.

fuses from loose connections. It is made in two sizes, with or without a china cover, for 25 and 50 amperes, the former size being but one-fourth inch larger than an ordinary ceiling rosette.

## THE TESTING OF TRAMCAR MOTORS.

IT will be in the memory of most of our readers that Major Cardew and Mr. Kapp have each devised methods for testing the efficiency of dynamos by a combination of machines, in which only electrical and speed measurements are required. Mr. Cary T. Hutchinson now proposes, in the New York *Electrical Engineer*, to use a similar device for getting the nett efficiency of a pair of tram motors, without disturbing the gearing or starting gear. The method has some merit, and likely enough will prove serviceable where tests have to be made more or less frequently. Efficiency tests of tram motors and gearing, with the different couplings of the field windings, are exceptionally important, for there is no doubt that more energy is wasted in some electric tramcar equipments than is usually known or expected; the large coal and water bills make the total loss evident, but do not locate the weak spot. Mr. Hutchinson's method is applicable to series or shunt wound machines, and he gives the detailed calculation for two series wound Sprague motors. To make the test the car is slung, and the two rolling axles are coupled by a belt so as to revolve at the same speed, and the motors are assumed to be identical and to run at the same P.D., which is kept constant during the test. He gives two methods; in the first, one of the machines runs as a motor and drives the second as a dynamo, the current of the dynamo returning to the motor, as in Hopkinson's method of testing two dynamos of similar capacity. In the second, the dynamo works on resistances.

First method :—Fig. 1, A and B are the two motors to be tested; G is a 500-volt dynamo, which must be of sufficient

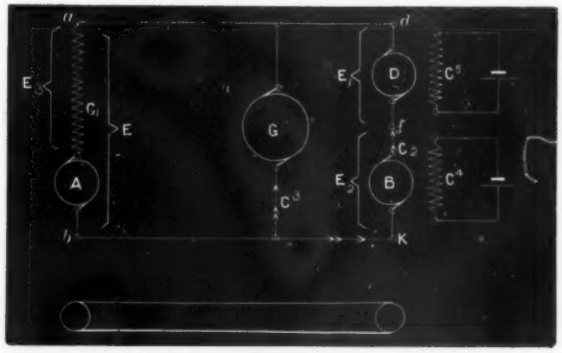



FIG. 1.

power to supply the difference of current in A and B; D is a dynamo generating an electromotive force equal to the loss of potential in the internal resistances of the machines, A, B, A, D, and must carry the same current as B. The generator, G, supplies the difference of current between the two machines, and D gives the potential. The fields of B and D are both separately excited.

To make the test, the current in the separately excited field coils of B is made equal to the current in A. The two machines are then running in fields of the same strength and at the same speed; it may therefore be assumed that the hysteresis, eddy current, and friction losses of the two are equal. Knowing, then, the input of A, and the output of B, and allowing for the field heating of B, the total loss in the couple of machines can be determined, and since the loss is equally divided between the two the efficiency is also known. This avoids the error made in Hopkinson's method from the assumption that the efficiency of one machine is found by extracting the square root of the combined efficiency, which is not quite correct, since the two machines are not working at the same load in his arrangement. The efficiency of only one machine, however, is calculated at a time. In fig. 1 machine A is being tested.

Let E be the P.D. at the terminals of the motor, A, kept constant,

$E_1$ be the P.D. at the terminals of D,
$E_2$ " P.D. " " " B,
$E_3$ " P.D. at the fields of A,
$C_1$ " current in A,
$C_2$ " current in the armature of B,
$C_3$ " current in G,
$C_4$ " current in the fields of B,
$C_5$ " " " " D,
R " resistance of the fields A or B,
$r$ " " " armature of A or B.

The test is easily made:—The current in the fields of B, $C_4$, is adjusted to the load on A, then $C_5$ is altered by resistances until $C_1 = C_4$; $C_4$ is then given another value, and the process repeated. Let $\phi$ be the efficiency of A, then it can be shown that the total losses which would occur in the system if B were running with the same loss as A, are equal to

$$2H = E C_1 - C_2 (E - E_1) + r (C_1^2 - C_2^2) + R C_1^2 \quad (1)$$

And the efficiency of A is

$$\phi = \frac{E C_1 - H}{E C_1} \quad (2)$$

Substituting value of H, and simplifying, we have

$$\phi = \tfrac{1}{2}\left[1 + \frac{C_2}{C_1} - (C_1 + C_2)\frac{R + r}{E}\right] \quad (3)$$

Thus only two measurements of current and one of the

* New York *Electrical Engineer*.

resistance, R and $r$, are required for each test if we keep E constant.

The main term $\frac{C_2}{C_1}$ is not largely affected by small variations in the instruments, and the ratio will remain sensibly constant within the limits of the errors of observation. The second term involves the sum of the two currents multiplied into $\frac{R + r}{E}$, which is constant for each observation. With the values of resistance and P.D. assumed, an error of 10 per cent. in $C_1 + C_2$ will only affect the efficiency by about 1 per cent. This equation shows plainly the variations of the efficiency for different couplings of the field magnets, for R will have a different value for every coupling of the coils.

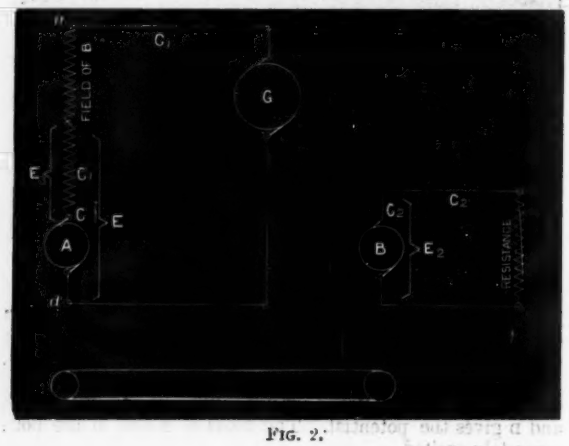



FIG. 2.

The same tests may be carried out in a simpler way by placing the field of B in series with the field of A, and passing the current from B through an adjustable resistance. The manner of coupling the machines in this case is shown in fig. 2. Equation 3 can be shown to be also applicable to this test.

## WATER POWER.

BY E. TREMLETT CARTER.

(*Continued from page* 360.)

### VI.

IT is not intended that the following table of the dimensions and constants of overshot wheels should represent the only sizes for the particular heads named, but that it should serve as a statement of the average of general practice, and a guide to the electrical engineer, who may find it necessary to erect an engine of this kind while finding it inconvenient to calculate the dimensions. Two sizes are given for each particular head, one for a high velocity the other for a lower speed; it will be seen that the former is a cheaper though less efficient engine in each case.

22. *Example.—Let it be required to determine the dimensions of an overshot wheel to work on an available fall of* 20 *feet, and to develop a maximum useful power of* 50 *H.P. Let it be assumed that water is plentiful, so that an unusually high efficiency need not be arranged.*

We shall commence by taking a peripheral velocity of the wheel of 10 feet per second, and a relative entrance angle of 20°. The ratio of the velocities may be about 1·8, so that

$$a = \left(\frac{1{\cdot}8 - {\cdot}8}{1{\cdot}8}\right) 20 = 9$$

And $$v = 1{\cdot}8 \,.\, v = 18 \text{ feet per second.}$$

This gives for the guide-fall,

$$h_1 = 1{\cdot}1 \frac{v^2}{2g} = \frac{1{\cdot}1 \times (18)^2}{64} = 5{\cdot}5 \text{ feet.}$$

Whence, taking $\theta = 12°$,

$$r = \frac{20 - 5{\cdot}5}{1 + 0{\cdot}978} = 7{\cdot}65 \text{ feet.}$$

We may make the wheel 15 feet 3 inches in diameter.

The hydraulic efficiency will be about,

$$\eta \text{ (hyd.)} = \frac{5{\cdot}5 + 30}{2 \times 20} = 89 \text{ per cent.}$$

And the commercial efficiency, being about 80 per cent. of this, will be,

$$\eta \text{ (commercial)} = 70 \text{ per cent. (approx.)}$$

The total flow of water per second at full power will be,

$$Q = \frac{550 \times 50}{62{\cdot}4 \times 20 \times {\cdot}7} = 35 \text{ cubic feet (approx.)}$$

Taking the crowns as 1 foot deep, the width of the wheel must be at least,

$$w = \frac{35}{\frac{1}{2} \times 1 \times 10} = 14 \text{ feet (say, 14 feet 6 inches.)}$$

The number of buckets may conveniently be,

$$n = 5\,r = 38.$$

The guide trough must be set at an angle to the horizontal of

$$a + \theta = 21 \text{ degrees.}$$

If water were not so plentiful a smaller quantity might be made to develop the same useful power, but with a more expensive wheel, by taking the alternative dimensions in the table.

23. *Brest Wheels.*—It will not be necessary to spend so much time in consideration of this and other forms of water-wheels as has been spent on the former kind, because the *principles* of construction and action are the same in every

DIMENSIONS OF IRON OVERSHOT WATER-WHEELS.

| Head in feet. H. | $v$. | $k$. | $\alpha$ (in degrees.) | $\beta$ (in degrees.) | $\theta$ (in degrees.) | Inclination of guide. (in degrees.) | V. | Guide fall. $h_1$. | Diameter in feet. $2r$. | Number of buckets. $n$. | Depth of crowns in inches. $d$. | Flow in cubic feet per second per 10 useful H.P. | Width in feet per 10 useful H.P. | Hydraulic efficiency. | Commercial efficiency. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 2·5 | 1·8 | 13 | 30 | 15 | 28 | 4·5 | 0·4 | 9·5 | 26 | 10 | 14·0 | 27·0 | 90 | 64 |
| 10 | 5·0 | „ | 13 | 30 | 15 | 28 | 9·0 | 1·4 | 8·5 | 22 | 10 | 15·0 | 14·5 | 87 | 61 |
| 15 | 5·0 | „ | 11 | 25 | 15 | 26 | 9·0 | 1·4 | 14·0 | 40 | 10 | 8·8 | 8·1 | 90 | 70 |
| 15 | 8·0 | „ | 11 | 25 | 15 | 26 | 14·4 | 3·4 | 12·0 | 32 | 10 | 10·0 | 6·0 | 88 | 65 |
| 20 | 8·0 | „ | 9 | 20 | 12 | 21 | 14·4 | 3·4 | 16·4 | 44 | 12 | 6·6 | 3·3 | 90 | 72 |
| 20 | 10·0 | „ | 9 | 20 | 12 | 21 | 18·0 | 5·5 | 15·3 | 38 | 12 | 7·0 | 2·8 | 84 | 70 |
| 25 | 10·0 | „ | 4·5 | 10 | 10 | 14·5 | 18·0 | 5·5 | 20·0 | 50 | 12 | 5·4 | 2·2 | 84 | 68 |
| 25 | 12·0 | „ | 4·5 | 10 | 10 | 14·5 | 22·0 | 9·3 | 15·5 | 40 | 12 | 5·8 | 2·0 | 83 | 67 |
| 30 | 10·0 | „ | 2·3 | 5 | 8 | 10·3 | 18·0 | 5·5 | 24·3 | 58 | 12 | 4·3 | 1·7 | 89 | 70 |
| 30 | 15·0 | „ | 2·3 | 5 | 8 | 10·3 | 28·0 | 13·3 | 16·5 | 44 | 12 | 5·0 | 1·3 | 76 | 61 |
| 35 | 10·0 | „ | 2·3 | 5 | 5 | 7·3 | 18·0 | 5·5 | 29·3 | 60 | 12 | 3·6 | 1·5 | 91 | 73 |
| 35 | 15·0 | „ | 2·3 | 5 | 8 | 10·3 | 28·0 | 13·3 | 21·5 | 42 | 12 | 4·3 | 1·0 | 80 | 64 |
| 40 | 10·0 | „ | 2·3 | 5 | 5 | 7·3 | 18·0 | 5·5 | 34·3 | 70 | 12 | 3·0 | 1·2 | 92 | 74 |
| 40 | 15·0 | „ | 2·3 | 5 | 5 | 7·3 | 28·0 | 13·3 | 26·5 | 52 | 12 | 3·6 | 0·9 | 81 | 65 |

form. Having devoted what may have appeared a large amount of space to overshot wheels, chiefly in elucidating these principles, it will now be necessary only to apply them. Brest wheels are used where there is a sufficient fall for the water to act partially by weight, yet not enough for the water to be carried efficiently over the top of the wheel. The top level is usually below the top of the wheel, the water being supplied at some point on the front of the wheel near the centre. If the stream enters at or below the centre, the wheel is known as *low brest*; if above, *high brest*. These wheels derive their name from the fact that the guide or wheel race is carried round the wheel from the penstock to the tail race in the form of a cylindrical race or brest, together with other details of a low brest wheel; this is shown in fig. 22, the brest extending from A to E. The materials of which the brest of wheels are formed are iron, as in fig. 22, masonry, as in fig. 23, and wood; the last-named being used only in the cheaper and less efficient engines. In some cases the brest is continued round the sides of the wheel, replacing the crowns and preventing the escape of water from the ends of the buckets or floats. This, however, though common, is not good practice, for the reason that if the brest is not placed very close to the sides of the wheel there will be a considerable loss of water in the clearance spaces, while if it is placed very close so as to reduce this loss the rings on the bearings must fit very tightly, or the end play will cause the wheel to come into contact with the brest; tight rings, of course, are objectionable on account of the loss due to friction against the brasses. It is well, therefore, to supply the wheel with two crowns, as in the overshot wheel. Since the brest prevents the escape of most of the water between the points, A and E (fig. 22), it follows that

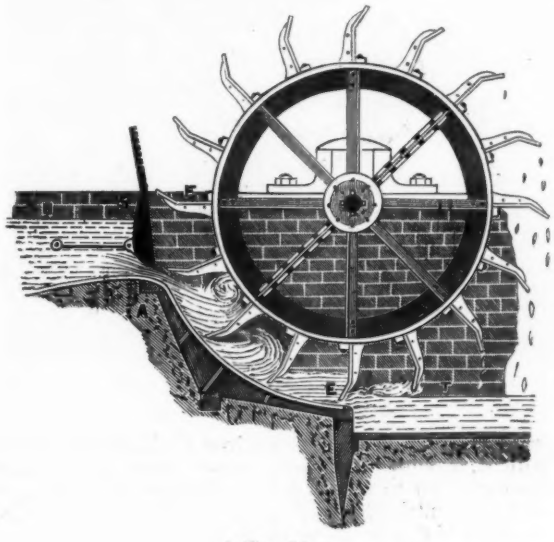



FIG. 22.

there is no need to provide capacious buckets, but merely flat floats, against which the water may impinge on entry, and upon which it may press during its descent to the tail-race. For the same reason the spaces between these floats may be much more completely filled with water than in overshot wheels. The coefficient of fill is usually from 0·5 to 0·75.

Clearance must be allowed between the brest and the floats to prevent contact in the event of any displacement or warping, and to allow of the passage of small stones and bits of wood without jamming the floats and tearing them from the wheel. With iron wheels and masonry or iron brests, the clearance need not exceed half an inch; but with wooden wheels or brests the clearance must be about twice as much. It will be evident that this clearance is a source of loss, inasmuch as water can pass through it in a constant stream without doing any work on the wheel. For this reason it should not be very large. In any case it will be necessary to place a screen or grating in the head race, to prevent the passage of large stones into the engine; and the best place for this is in the penstock, where the velocity of the water is small. The mesh of this screen must not be very small, or frictional loss of head will take place to a very great extent; on the other hand, it should not be less than the clearance.

Water is brought to brest wheels in three different ways, the choice between which in any case will be determined by local considerations and the size of wheel which it is intended to erect. The most efficient of these methods is the *overfall sluice*, shown in fig. 23. The water is here taken from the

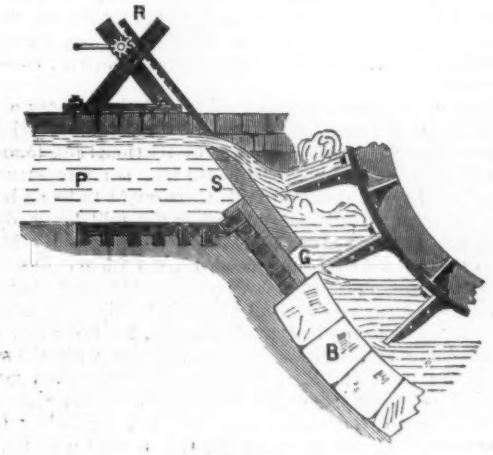



FIG. 23.

top of the stream, with but little fall before entering the wheel. Unless the velocity of the head-water is fairly large the wheel will be required to run slowly and will on that account have to be very large. This form of sluice is not to be recommended where the velocity of the head-water is not sufficient to carry it well into the buckets, for a slow entry would cause considerable loss in the clearance. The required head due to this velocity is about eight or ten inches, according to the clearance. Wheels of large or moderate size supplied in this manner have a commercial efficiency of from 60 to 70 per cent.

The *underfall sluice* shown in fig. 22, supplies a faster current to the wheel, and permits of a higher velocity in the wheel itself, but involves a lower commercial efficiency on account of the reduced wheel-fall. This form is adapted to sites where the velocity of the stream is low, where the engine must be erected at a small prime cost, or where there is considerable variation in the top level. In the last named case the underfall sluice takes the form of a *guide sluice*, which constitutes the third manner of bringing on the water; this is shown in fig. 24. Guide sluices are provided with two

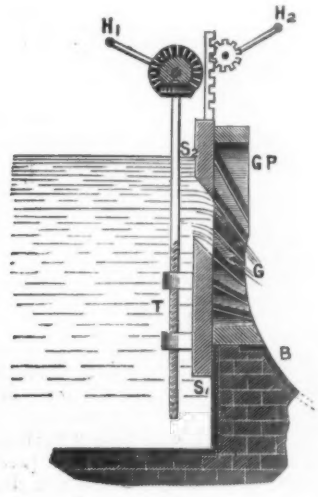



FIG. 24.

slides having independent adjustments, so that both the level and the amount of opening of the gate can be adjusted to suit the level of the head-water and the demand for water in the engine. By means of the handles, $H_1$ and $H_2$, these adjustments are made, the slides, $S_1$ and $S_2$, leading water into

the top or bottom guides, and into one or more of these, according to the immediate conditions. The guides are all tangents to a common circle, having the same radius as the wheel, the centre of which is so placed that the relative entrance angle is $\beta$.

The inclination of the lowest or any one guide having been determined, it is a simple geometrical operation to find the inclination of the others. This form of sluice best adapts itself to varying conditions of head and flow, and gives an efficiency depending on the depth at which it takes the water from the head race. Usually its efficiency is the same as for an ordinary underfall sluice for the same fall, viz., from 40 to 60 per cent.

Water is discharged into the tail race at the velocity of the wheel, but may pass along it at a very much lower velocity if there is much backwatering due to frictional resistance in the tail, or if the declivity of the tail race is not constructed properly. In well designed mills there ought to be no backwatering, even at full load and when the mill lower down the stream is not working; but there are plenty of mills in which the tail race becomes flooded from these causes. In the former case it is not necessary to provide any clearance between the floats and the tail water, but only an inch or so of clearance from the bottom of the race, for the wheel and the water are moving in the same direction with the same speed. In the latter case, however, the tail race must be trenched out to such a depth that the floats just skim the tail water when the engine is at full load, and clear it at lower loads. The arrangement for this is shown in fig. 22, where the floats are permitted to dip to a depth of only 2 inches into the tail water. In either case, but more especially in the case of totally immersed floats, there would be a tendency on the part of radial floats to lift the water from the tail race as the floats left the water. This would cause a wasteful back pressure on the wheel, and must be prevented by feathering the floats. In some cases the floats are feathered at the tips only, in other cases the inclination is carried back to the sole of the wheel, the floats being merely flat boards or plates set at the required angle. The angle of feathering must be such that, with the wheel and the water running at their proper speeds, the floats will slide out of the water without lifting any of it. This angle is found in a manner shown by fig. 25. The line, A B, is the level of

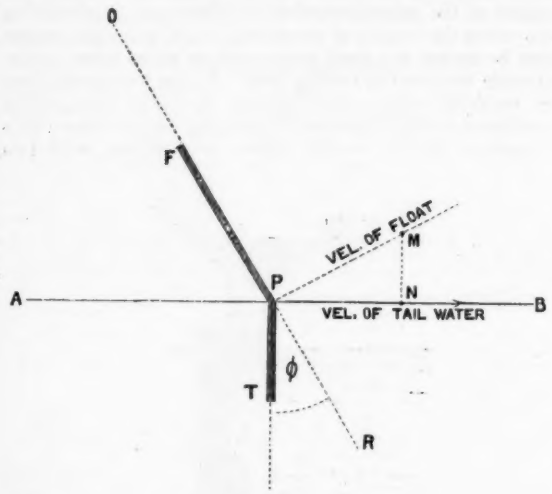



FIG. 25.

the water in the race; O R is a radius of the wheel through any float. Draw P N to represent the direction and magnitude of the tail velocity, and P M the same for the wheel velocity at the tip of the float. Join M N, then the direction of M N is the direction of the feathered part of the float. Thus, if P T is drawn parallel to M N, the angle, R P T, is the angle of feather. It will be evident that since the position of the float is constantly changing, the feathering which is thus fixed is only approximately correct. It is sufficiently good for general practice, and no arrangement for variable feather has yet been introduced into water wheels.

To permit the escape of air from the spaces between the floats when they are filling, ventilation holes must be provided. The width of the entering stream and the degree of filling of the buckets are such that, if no escape behind the wheel was provided, the air would prevent the free entry of the water and would cause most of it to pass away down the clearance spaces. In small wheels ventilation is effected by means of a number of circular holes in the sole, a row of these holes being placed under each float. In larger wheels the methods shown in figs. 26 and 27 are most common; the

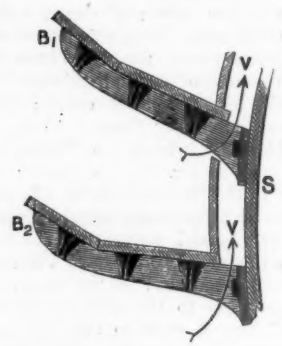



FIG. 26.

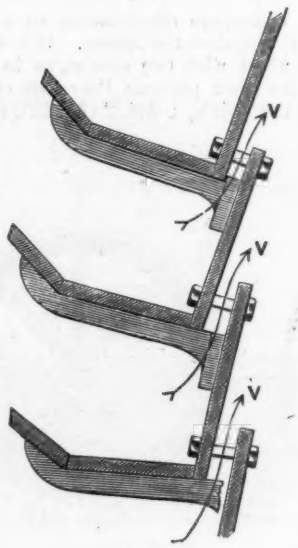



FIG. 27.

former allowing the air to escape from the bucket to the one above it, and suiting wheels without crowns, the latter allowing the air to pass away to the inside of the wheel, and being more suitable for wooden wheels or wheels with crowns. The depth of the crown, or the radial depth of the floats, is larger in breast than in overshot wheels, being usually about two feet. These wheels are run at a lower speed than the overshot, the most common peripheral velocity in iron wheels being about 4½ feet per second, while wooden wheels are frequently run at about 6 feet per second. In practice the velocity of the wheel varies from one-half to nearly equal to the entrance velocity of the water.

Breast wheels are used for heads from 5 to 15 feet, where at least four feet of local fall can be developed. This fall is, in general, about 85 to 90 per cent. of the head. A very common form of high breast wheel is that in which the water is admitted into the wheel at 30 degrees above the centre. The diameter of a wheel having this design would be

$$D = \frac{4}{3}(H - h_1)$$

where $h_1$ is the guide fall. This design is very good for wheels of over 11 feet diameter, *i.e.*, for falls of from 8 feet upwards. It is not well to build breast wheels smaller than 11 feet in diameter; so that at smaller falls than 8 feet the water must be admitted lower down. Hence the necessity for low breast wheels, where the diameter at small falls is so much larger than the fall.

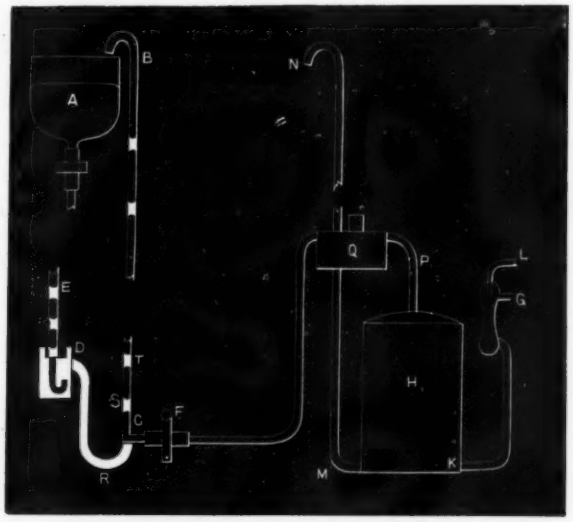
As an illustration of what can be done by wheels of this

type, in electric lighting, we may cite the case of the Buckingham electric light station. Originally this station was a country flour mill, driven by a couple of low breast wheels supplied with water from the Ouse, which is at that place a small stream. Little additional machinery was needed to turn this into a small electric light station, capable of supplying power to some 300 lamps; and thus, without the purchase of extensive steam plant, the prospects of this light in that place could be tested. Under the able direction of Messrs. Parr and Gillies, the supply by means of water power has had to be supplemented by steam power, owing to the increased demand; but it has been found that water is by far the cheaper of the two means of developing power. There are in this country countless small water-wheels, in disused flour and other mills, which might thus be used to initiate and test the prospects of the electric light in country districts.

*(To be continued.)*

## A FURTHER NOTE ON A NEW MERCURY ELEVATOR.

OUR paragraph on a new form of elevator, which appeared in our issue for August 5th, p. 166, has attracted some attention, and in view of Mr. Arthur Spain's letter (*vide* ELECTRICAL REVIEW, August 19th), it may interest our readers to have the further details, which we said might be found in the *Philosophical Magazine*.




Mr. Smith's mercury elevator is nothing more than a Sprengel pump inverted, and working backwards. Where a vacuum is formed under ordinary circumstances, air is forced in, and instead of little cylinders of mercury falling, they are raised.

The construction is shown in the diagram. A is the cistern of the Sprengel or other mercurial pump; B, C, D, a tube furnished with a side-tube at C, and attached at D to the catch of the Sprengel pump, E. By means of the pinch-cock, F, the supply of compressed air is controlled. The air may be compressed either by an ordinary condensing pump, driven by any prime mover, or by the following arrangement, which may be used when there is a supply of water at a sufficient pressure.

G is an ordinary water pump. When water, under pressure, enters at L, air is drawn in at G, and is discharged at K into a copper cylinder, H; here the air and water separate; the air passes through the tube, P, to a drying chamber, Q, and to the elevator, R, C, B,; the water rises in the tube, M, N, and is discharged at N (the tubes are shown broken, to economise space in the diagram); the pressure of the air is controlled by the pressure of the supply at L, and by the vertical height of M, N.

When the elevator is to be used, water is turned on at L, till it flows freely at N, and F is slightly opened; then the Sprengel pump is started. As soon as sufficient mercury has collected to overflow, it is immediately raised by the compressed air into A, the sum of the lengths of the little columns, such as S, T, &c., being less than the length of the column, R, D.

In the instrument which has been at work for the last two years in the Millard laboratory, the height of the tube, M, N, is about 8 feet, and the pressure of the water at L, 36 lbs. per square inch.

## THE BRITISH ASSOCIATION.

### THE EFFICIENCY OF TRANSFORMERS AT DIFFERENT FREQUENCIES.

By W. E. AYRTON and W. E. SUMPNER.

(*Read before Section A, August 5th*, 1892.)

SOME years ago Mr. Mordey published in the *Journal of the Institution of Electrical Engineers* the results of some experiments which appeared to show that when a transformer of the Mordey type of construction was working at a given load, the waste of power was less at a frequency of 100 than at a higher or lower frequency. In 1888, to test this point, experiments were carried out at the Central Institution by Messrs. Lamb, Smith, and Woods, the power put into and taken out of a Mordey type of transformer, being measured by the electrometer method, and it was for the purpose of these tests that there was constructed the large non-inductive resistance that was described by Mr. Mather and one of us before the Physical Society last year.

But, although this method is theoretically one of the best for ascertaining the power given by any current to any circuit, the percentage error in measuring the efficiency is, of course, the percentage error in measuring the power put into or taken out of the transformer; and, as it is very difficult to avoid making errors of one or two per cent. with the electrometer method, it is almost impossible to be sure of changes of this magnitude in the efficiency produced by a variation in the frequency.

Subsequently tests were made by others of the students, employing other methods for measuring the power, but it was not until one of us had devised the method that appeared this year in the technical press for measuring *directly* the losses in a transformer that we felt in a position to express an opinion regarding the actual effect produced by variation of frequency on the efficiency of a transformer.

Except under special circumstances, to be subsequently referred to, this method requires for its employment two transformers similar in type and output, and a third transformer, which may be of much smaller output, for supplying the energy lost in the coils of the two large transformers.

The detailed working of the method will be understood on reference to fig. 1. The fine wire coils of the two transformers, A, B, are connected in parallel through the high pressure switches, *s*, *s*. The thick coil of A is connected directly with the mains, while the thick coil of B has one of its ends joined with one of the mains, and the other in series with a dynamometer, D, a switch, $S_2$, the current coil of the wattmeter, $W_1$, the secondary of the subsidiary transformer, C, and, finally, with the other main lead. A switch, $S_1$, is placed in one of the mains, as indicated in the figure, so that the current supplied directly from the mains can be switched off when desired. The primary of transformer, C, is connected with the mains through an adjustable resistance, $R_3$, and a switch, $S_3$. A wattmeter, $W_2$, has its current coil joined up so as to be traversed by the current entering the parallel circuit formed by the primaries of A and B, and its pressure coil placed in series with the non-inductive resistance, $R_2$, across the mains. The pressure coil of the other wattmeter, $W_1$, is connected in series with the non-inductive resistance, $R_1$, across the secondary of the auxiliary transformer, C.

If the switches, $S_1$, $S_2$, be closed, the currents flowing are merely the magnetising currents required for the transformers, A and B, and $W_2$ merely measures the open circuit losses. Unless the secondary of C be short circuited, no current will flow through the thick coil of B, for the magnetising current is then supplied by the thin coil after transformation by A. If now switch $S_3$ be closed, so that the secondary of C supplies a P.D. of say, 6 volts to the circuit formed by the thick coils of A and B, large currents will flow through the transformers. The P.D. between the terminals of A will be, of course, the voltage of the mains; for example, 100, but the P.D. at the terminals of B will be either 106 volts or 94 volts, according as the six volts supplied by the secondary of C are in opposite phase, or in the same phase, as the 100 volts between the mains. (Indeed, if there were considerable magnetic leakage in the transformer, C, or if $R_3$ were a highly inductive resistance, the P.D. of six volts supplied by C would be out of phase with the voltage on the mains, and the P.D. at the terminals of B might be anything between 106 and 94 volts.)

If there be a P.D. of 106 volts between the terminals of B, this transformer is being used as a step-up transformer, and A is converting downwards. If, however, there be only 96 volts between the terminals of B, it is A which is working as the step-up transformer, and B which is converting downwards. In the majority of the cases to be subsequently described, the six volts supplied by C were sufficient to drive the full load currents through the transformers.

The load, W, we take as being measured by the product of the current indicated by D and the P.D. supplied to the primary of the step-up transformer. If A is used for converting upwards, this load is simply 100 times the current in amperes, whereas if B is used as the step-up transformer, the power returned to the mains by

A is 100 times the current in ampères, and if to this we add the two power losses measured by $W_1$ and $W_2$, we obtain the power taken from the mains and supplied to the primary of B. If $w$ be the load in watts supplied to the step-up transformer, if $w_1$ and $w_2$ be the watts at this load measured by $W_1$ and $W_2$ respectively, and if $\lambda$ be at the same time the loss of power in the leads used in joining up the transformers, in the coils of the dynamometer, D, and in the current coil of $W_1$, the total loss in the two transformers is

$$w = w_1 + w_2 - \lambda,$$

and the efficiency of the double conversion is

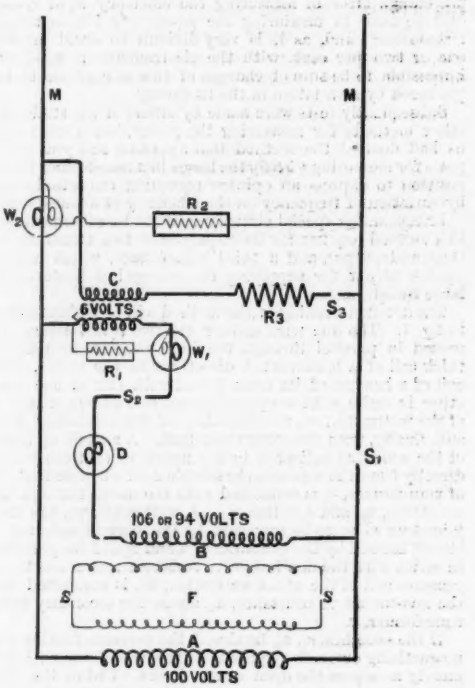
$$\eta = 1 - \frac{w}{W}$$

The advantage of this method of determining efficiency, as pointed out some years ago by Dr. Hopkinson in connection with a similar method of measuring the efficiency of dynamos and motors, is that a small error in determining either $w$ or $W$ will make practically no difference in the calculated value of $\eta$. For instance, as the value of $\eta$ for *two* transformers is about 90 per cent., $w$ is about $\frac{1}{10}$th part of $W$, and it follows that an error of 10 *per cent.* in estimating the ratio $w/W$ only affects $\eta$ to 1 *per cent.*, and only affects the calculated efficiency of each transformer to *one-half per cent.*

It would have been more accurate had we placed the dynamometer, D, in circuit, with the thick coil of A, rather than with the thick coil of B, but the currents in the coils of A and B for closed magnetic circuit transformers differ to such a slight extent, that either current may be approximately taken to represent the load without introducing any appreciable error in the determination of the efficiency.

The instruments used were of a rough character, and no special care was taken with them; for our object was rather to see how far measurements made by this method with common instruments could be relied upon, than to obtain the most accurate results possible.

D (see fig. 1) is an ordinary Siemens dynamometer measuring up to




A, Transformer A; B, Transformer B; C, Transformer C; F, Fine wire coils at 2,000 volts; M, Mains at 100 volts.

FIG. 1.

55 amperes for one revolution of the pointer when the thick coil is in circuit.

$W_2$ is a Ganz wattmeter, supplied, as usual, with two non-inductive resistances. In the following experiments its sensibility was such that one revolution of the pointer corresponded with about 1,200 watts.

$W_1$ is a Siemens dynamometer as made commercially, but modified so as to form a wattmeter by connecting the mercury cups forming the ends of the movable coil with two separate terminals. This swinging coil was used, in series with a suitable non-inductive resistance, $R_1$, as the pressure coil of the wattmeter, one of the fixed coils being traversed by the main current. When large currents were flowing through the thick coils of A and B, a current of 8 or 10 amperes often passed through the *volt-coil* of this wattmeter, and its attached resistance, $R_1$, but although the power so wasted was quite appreciable, consideration of fig. 1 will show that the reading of the wattmeter, $W_1$, is not affected by it in the least, and that it thus does not enter into the calculation of the efficiency. An ordinary Cardew voltmeter was used for the adjustment of the potential on the mains.

The transformers tested were: $M_1$, $M_2$, two transformers of the Mordey type, each of output 4·5 kilowatts, converting from 2,000 volts to 100 volts (or 50 volts). They are numbered 1874 and 1872. We shall for brevity allude to them respectively as $M_1$ and $M_2$.

$M_3$, one transformer of the Mordey type, of output 3 kilowatts, converting from 2,000 volts to 100 volts (or 50 volts). Its number is 1832, and in what follows it is alluded to as $M_3$.

$M_4$, one transformer of the Mordey type, of output 1·5 kilowatts, converting from 100 volts to 100 volts. It has three coils, each of the same number of turns, and occupying spaces proportional to the numbers 1, 1, and 2, respectively. The transformer was wound in this way for experimental purposes, but in other respects it does not differ in construction from the ordinary type made by the Brush Company in 1887. It is alluded to in the following experiments as $M_4$.

H, one Hedgehog transformer, made by Messrs. Swinburne & Co., of output 4 kilowatts, converting from 2,000 volts to 100 volts. It is referred to by the letter H.

A small transformer of change ratio 6 to 1 was occasionally used as the subsidiary transformer, C. It was not, however, of any recognised commercial type and the magnitude of its efficiency does not enter into the tests.

The losses in the leads were carefully determined, and confirmed by measurement made with different methods. The same leads and instruments were used in all the experiments. The first method of testing was to measure the resistances of the different coils and leads and calculate the losses for the currents used. These measurements were confirmed by passing steady currents of 30 and 40 ampères (measured by a standard d'Arsonval galvanometer used as an ammeter in shunt to a platinoid strip) through the leads and measuring with the aid of a standard voltmeter (a second d'Arsonval galvanometer used in series with known resistances) the power lost in the leads for these currents. The same experiment served to calibrate the dynamometer D. The wattmeters, $W_1$ and $W_2$, had been previously calibrated by means of the same two standard instruments. The measurements were made when both the thin and the thick coils of the dynamometer, D, and the wattmeter, $W_1$, were in circuit, since in the actual transformer tests it was occasionally found necessary to change these coils. The measurements of the losses in the instruments and leads were further confirmed by tests with *alternate currents* of the same frequencies as those used in the measurements; and it will be apparent that one of the advantages of the method of testing the efficiency of transformers which we have employed arises from the fact that the apparatus required for the efficiency measurements can be used for determining the losses in the leads, &c., *without any alteration of the connections*. For if the switch, $S_1$, be open, and switches $S_2$ and $\bar{S}_2$ be closed, and the primaries of the transformers, A and B, are short circuited, the reading of the wattmeter, $W_1$, will at once measure the losses occurring in the testing apparatus itself when any special current (measured by D) is passing through it.

The measurements made by these different methods were in quite satisfactory accordance with each other. With a current of 40 ampères the loss in the leads, when the thick coils of D and $W_1$ were used, was 55 watts. When the thin coil of D was substituted for the thick coil the extra loss at 40 ampères was 70 watts, and an equal increase in the loss was caused by using the thin coil of $W_1$, instead of the thick coil.

The losses occurring in the coils of the transformers can be measured independently of the other losses by simply leaving the switch, $S_1$, open and taking the reading of $W_1$ for different alternating currents flowing through D. The two transformers, A and B, are so connected that a P.D. of a few volts will cause large currents to flow through the thick coils when the switches, $s$, $s$, in the secondary circuit are closed. Of course the iron cores are magnetised slightly and a certain amount of energy is absorbed by hysteresis, but this is quite negligible compared with that lost in the copper. For, at most, the voltage corresponding with the induction of the core is only that needed for driving the currents through the resistance of the transformer coils. This is only about one per cent. of the ordinary voltage of the transformers, and as the losses in the iron vary as the square of the induction density (more accurately as $B^{1\cdot6}$), the core losses are only 0·01 × 0·01, *i.e.*, 0·0001 of the normal losses occurring in the use of the transformer.

It thus becomes possible to investigate the very important matter of the variation of the core losses under different conditions of load. All that need be done is to determine:—

1. The total losses occurring in core, coils, and testing apparatus for different currents when $S_1$ is closed, and

2. The total losses in the coils and testing apparatus for the same currents when $S_1$ is open. The difference between the losses found for any particular current is the loss in the core for that particular load.

It was pointed out in the article in the technical press already referred to, that the reading of $W_2$ practically gave the iron losses in the two transformers, and that $W_1$ gave the losses caused by the heating effect of the currents in the coils, &c. The measurements made with closed circuit transformers have entirely confirmed this view.

Thus for the two 4½-kilowatt transformers of the Mordey type ($M_1$ and $M_2$), tested at 100 volts and a frequency of 160, the reading of $W_2$ gradually changed from 220 watts, on open circuit, to 230 watts at a load of 2,500 watts, and to 235 watts at a load of 5,000 watts. Whereas the core losses as determined by the subtraction method were 220 watts on open circuit, 220 watts at a load of 2,500 watts, and 227 watts at a load of 5,000 watts, or practically the same as the watts as measured by $W_2$. In another test at a frequency of 150, the reading of $W_2$ changed from 210 watts on open circuit to 222 watts at a load of 4,000 watts, the iron losses as calculated by the difference method diminishing gradually from 210 watts on open circuit to 200 watts at a load of 4,000 watts.

In another test at the same frequency the reading of $W_2$ altered from 215 watts on open circuit to 210 watts at full load, while the iron losses were found exactly the same as the corresponding readings of $W_2$ up to a load of 3,000 watts; afterwards, however, the iron

losses were slightly greater. In a test at a frequency of about 100 the reading of $W_2$ decreased from 260 watts to 250 watts as the load increased up to 4,000 watts, the iron losses being the same up to a load of 2,500 watts and being slightly less afterwards and equal to 230 watts at a load of 4,000 watts. In a later test at a frequency of 100 the reading of $W_2$ only changed from 285 watts to 290 watts from open circuit to a full load of 5,000 watts, while the iron losses diminished under the same circumstances from 285 watts to 275 watts.

In all these experiments numerous tests at intermediate loads were taken, and the general smoothness of the curves obtained by plotting the observations is such as to justify considerable confidence in the character of the results, the slight differences between the curves denoting the readings of $W_2$, and those representing the iron losses are sometimes in one direction and sometimes in the other, and are to be regarded as an indication of the extent of the experimental error to which the measurements are subject, rather than as any certain evidence of alteration of the core losses with the load. In fact, the experiments seem to show that with closed circuit transformers, at any rate, the core losses are practically constant at all loads. This conclusion is only what theory indicates, but it has frequently been doubted, as many published efficiency tests of transformers have indicated, that the core losses diminish as the load increases.

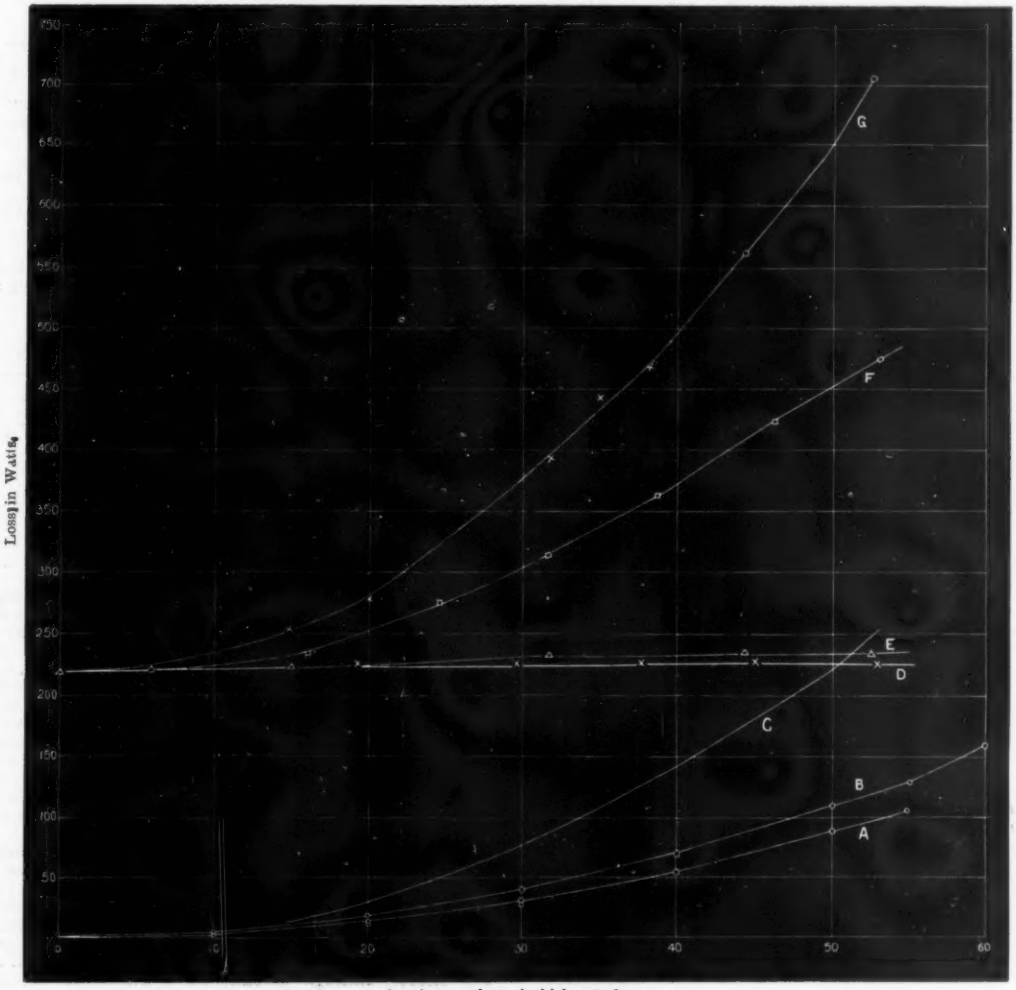
This constancy of the iron losses is further evidenced by tests made with the other two Mordey transformers. Thus, in testing the combination of the 4,000-watt Mordey ($M_1$) with the 3,000-watt Mordey ($M_3$), the iron loss at a frequency of 160 only altered from 185 watts at no load to 175 watts at 4,200 watts load. In another test at a frequency of 200, the core losses changed from 170 watts at no load to 155 watts at a load of 4,200 watts. In a test of the 1,500-watt Mordey ($M_4$), the iron losses at a frequency of 160 were found constant within 1 per cent., while the load changed from 0 to 3,000 watts, or double full load.

When the open magnetic circuit transformer was used, the measurements were not so satisfactory. Two or three reasons may be assigned for this. Owing to the large magnetising current the reading of the dynamometer, D, cannot be taken to indicate the current in the thick coil of A, as well as that in the thick coil of B. Also owing to the great difference in the regulation of the Hedgehog transformer when converting up or down, the voltage on the transformer, C, had to be considerably greater than in the previous tests when the full load currents were flowing, and, consequently, while one of the transformers, A, B, is worked at the proper voltage, the other is worked at a voltage considerably different from 100. The curves obtained are sometimes of a curious character, and we have not yet had time to fully explain them. As we hope to repeat these tests, we prefer to postpone the publication of the results referring to the core losses of open circuit transformers. Our experiments, however, indicate that the iron losses do not alter by as much as 10 per cent. when the load is increased from 0 to full load.

Before summarising the results obtained, it will be well to explain in detail the arithmetical working by means of which the efficiency is obtained from a single set of measurements with the three instruments, $W_1$, $W_2$, and D. When the two large Mordey transformers ($M_1$ and $M_2$) were being tested at a frequency of 107, it was observed that when the current as read by D was 44·8 ampères, $W_2$ indicated 310 watts, and $W_1$ 290 watts. In this particular experiment, $M_1$ was on the mains at 100 volts, and was used as a step-down transformer, the volts on the primary of $M_2$ being greater than 100 volts. While, therefore, 44·8 × 100 watts were being returned to the mains by $M_1$, the thick coil of transformer, $M_2$, was being supplied with 4,480 + 310 + 290 watts. The load on the step-up transformer was thus 5,080 watts. The total loss in the two transformers is, however, less than 600 watts, since there is a considerable loss in the leads and dynamometers, &c. The loss in the leads at 44·8 ampères is 63 watts. The thin coil of $W_1$ was used in this particular test, so that an additional loss of 89 watts must be allowed for. No extra allowance has to be made for D, as the thick coil was used, and the loss in this coil is already taken into account in estimating the loss in the leads. The total loss in the testing apparatus for this current is therefore 152 watts, and the total loss in the transformers is thus 600 − 152 = 448 watts. The joint efficiency at this load of 5,880 watts is therefore $1 - \frac{448}{5,880} = 1 - 0883 = 91{\cdot}18$ per cent. This number is the product of the efficiencies of the two transformers, and, if these are

CURVES OF LOSSES IN No. 1872 AND 1874 MORDEY TRANSFORMERS.

Primary volts, 100 ~ 160; $M_1$ used as step-down transformer; $M_2$ used as step-up transformer; load = 100 $a$ + total losses.




A, Loss in leads; B, Difference of loss of thin and thick coils of dynamometer and split wattmeter; C, Copper losses in transformers; D, Iron losses E ($W_2$), Watts from mains; F, Total transformer losses; G, Total losses (transformers, leads and one thin coil).

FIG. 2.

assumed to be equal, the true efficiency is obtained by taking the square root of 0·9118 giving 95·5 per cent. Also if the copper losses at this current, determined by the method already described, be subtracted from the total loss of 448 watts, we obtain 275 watts as the iron losses at this load. This only differs by 15 watts from the actual reading of $W_2$.

This process has been gone through for each of the efficiency determinations made; but in order to simplify the work, curves have been plotted denoting respectively the losses in the leads, in the transformer coils, the total losses in leads and transformers, the total losses in the transformers, the losses in the core, and the corresponding power supplied by the mains and measured by $W_2$.

The curves shown in fig. 2 indicate a complete set of observations made on the two large Mordey transformers, $M_1$ and $M_2$. As many as 30 such sets were taken in connection with different combinations of the transformers. Several of these had to be rejected from various causes. For instance, it was at first arranged by means of a combination of switches, to make one wattmeter do the work of the instruments, $W_1$ and $W_2$, but after several measurements had been taken, it was found that the alteration of the resistance of the circuit caused by the introduction of the wattmeter coil altered the currents flowing to a serious extent. The majority of the tests, however, confirmed each other in a very satisfactory manner. It is unnecessary to give the details of all the measurements, and we shall, therefore, merely give the numbers denoting the losses at different loads. These losses are interpolated from the curves drawn through the actually plotted points. The following table shows the results obtained from five sets of observations, at various frequencies, on the two large transformers, $M_1$, and $M_2$:—

COMBINED LOSSES IN TWO 4½ KILOWATT TRANSFORMERS OF THE MORDEY TYPE.

| Load in watts. | Approximate frequency in periods per second. | | |
|---|---|---|---|
| | 100 | 120 | 160 |
| | Loss in watts in the two transformers. | | |
| 1,000 | 292 | 270 | 229 |
| 2,000 | 303 | 280 | 241 |
| 3,000 | 335 | 305 | 275 |
| 4,000 | 375 | 345 | 320 |
| 4,500 | 400 | ... | ... |
| 5,000 | 425 | ... | ... |

From these numbers we obtain the following values for the efficiency of each of these two transformers:—

| Load in watts. | Approximate frequency in periods per second. | | |
|---|---|---|---|
| | 100 | 120 | 160 |
| | Efficiency of each transformer. | | |
| 1,000 | 84·46 | 85·59 | 88·58 |
| 2,000 | 92·19 | 92·76 | 93·84 |
| 3,000 | 94·27 | 94·79 | 95·30 |
| 4,000 | 95·22 | 95·60 | 95·91 |
| 4,500 | 95·46 | ... | ... |
| 5,000 | 95·76 | ... | ... |

From these numbers it follows: 1. That the greater the frequency the higher the efficiency for any particular load. 2. That the greater the load the higher the efficiency for the same frequency.

Both these results follow, of course, from the fact that the iron losses are the same at all loads for a given frequency and diminish as the frequency increases. And they do not, for these particular transformers at any rate, confirm the results referred to at the commencement of this paper, that the efficiency is a maximum at the frequency of 100.

The open circuit losses expressed as percentages of full load are 3·2 per cent., 2·8 per cent., and 2·36 per cent., at frequencies of 100, 120, and 160 periods per second.

If the iron losses be constant for all loads at a given frequency it can easily be proved that the efficiency of a transformer must be a maximum when the copper losses become equal to the iron losses. And calculation shows that, for these two 4½ kilowatt transformers of the Mordey type, this equality will occur at a load of 7,200 watts at a frequency of 100, at a load of 5,500 watts at a frequency of 160, and at a load of 5,000 watts at a frequency of 200 periods per second, when the maximum efficiencies become 96 per cent., 96·1 per cent., and 96·3 per cent. respectively. There is, therefore, no great difference between the maximum efficiencies at different frequencies, but the higher the frequency the lower the load at which the maximum efficiency occurs.

The following table summarises the results obtained from the tests of the 3,000 watt ($M_3$) and the 4,500 watt ($M_1$) transformers of the Mordey type combined:—

| Load in watts. | Frequency in periods per second. | | |
|---|---|---|---|
| | 107 | 160 | 200 |
| | Loss in watts in the two transformers. | | |
| 0 | 235 | 185 | 175 |
| 3,000 | 320 | 265 | 255 |
| 4,000 | 410 | 340 | 365 |

From these numbers we obtain the following values for the *joint* efficiencies of these two transformers:—

| Load in watts. | Frequency in periods per second. | | |
|---|---|---|---|
| | 107 | 160 | 200 |
| | Joint efficiency of the two transformers. | | |
| 3,000 | 89·33 | 91·17 | 91·50 |
| 4,000 | 89·75 | 91·50 | 90·88 |

Now, from the former tests we know the efficiency of $M_1$ at these loads and at two of the frequencies. We can thus obtain, by division, the efficiency of $M_3$ as follows:—

| Load in watts. | Frequency in periods per second. | |
|---|---|---|
| | 107 | 160 |
| | Efficiency of transformer, $M_3$. | |
| 3,000 | 94·76 | 95·66 |
| 4,000 | 94·25 | 95·41 |

The efficiency of the small 1,500 watt transformer ($M_4$) of the Mordey type was tested at a frequency of 150, and found to be 90·2 per cent. at a load of 1,500 watts, and higher at a larger output. The method used in testing this transformer is of some interest, arising from the fact that, as already stated, this transformer was for special experimental reasons so wound that it transformed from 100 volts to 100 volts. Now, when the change ratio of a transformer is unity, it is not necessary to employ another similar transformer when using our method of testing the losses directly since the primary and secondary coils can be employed, one to take energy from the mains, and the other to give back what is not lost in the transformation. Of course, an auxiliary transformer (C, fig. 1) must be employed, but the two transformers, A and B, in the figure, are replaced with the single unity-change-ratio-transformer, $M_4$.

As the large transformers of the Mordey type are wound with two thick wire coils in addition with the fine wire one in order that the transformers may, if required, be used on the three-wire system; it is possible to measure the efficiency by the method just described without the employment of a second similar transformer. And tests that we made in this way confirmed those previously carried out. But as the fine wire coil of the transformer is not used, this method, although excellent for a transformer whose change ratio is unity, is not to be recommended for one which transforms from 50 or 100 to 2,000 volts. Indeed it is obvious that if the test be made in the way just described, the advantage of dispensing with the duplicate transformer is counterbalanced by the fact that the transformer tested can only be used at what is practically half load, and the copper losses are, therefore, proportionately greater than when the transformer is used in the ordinary way at full load. Employing, therefore, two similar transformers as well as a small auxiliary transformer, as in fig. 1, is much to be preferred.

A large number of tests were made by combining the Hedgehog transformer, H with $M_1$ and with $M_3$, and, although the results (as already mentioned) were not as satisfactory as when two Mordey type of transformers were employed, they were sufficiently accurate to show that neither at no load nor at full load is there any great difference apparently between the power wasted in a Hedgehog and in a Mordey type of transformer of the same output. On this point, however, we shall say more when we have had more time to analyse the results we have already obtained with the Hedgehog transformer.

In conclusion, we wish to express our thanks to the Brush Company for so kindly lending us the two 4½ kilowatt transformers, and also our obligations to several students at the Central Institution, and more especially to Messrs. Baillie, Baylay, and Clift, for their interest and energy in carrying out the experiments, and in reducing the results.

## GENERALISATION OF MERCATOR'S PROJECTION PERFORMED BY AID OF ELECTRICAL INSTRUMENTS.

BY LORD KELVIN, P.R.S.

THE following mode of generalising Mercator's Projection is merely an illustration of a communication to Section A of the British Association at its recent meeting in Edinburgh, entitled, "Reduction of every Problem of Two Freedoms in Conservative Dynamics to the Drawing of Geodetic Lines on a Surface of given Specific Curvature." An abstract of this paper appeared in a recent issue of *Nature*.

In 1568 Gerhard Krämer, commonly known now as Mercator (the Latin of his surname), gave to the world his chart, now of universal use in navigation. In it every island, every bay, every cape, every coast line, if not extending over more than two or three degrees of longitude, or farther north and south than a distance equal to two or three degrees of longitude, is shown very approximately in its true shape; rigorously so if it extends over distances equal only to an infinitesimal difference of longitude. The angle between any two intersecting lines on the surface of the globe is reproduced rigorously without change in the corresponding angle on the chart.

Mercator's chart may be imagined as being made by coating the whole surface of a globe with a thin inextensible sheet of matter, sheet india-rubber, for example (for simplicity, however, imagined to be perfectly extensible but inelastic); cutting away two polar circles to be omitted from the chart; cutting the sheet through along a meridian, that of 180° longitude from Greenwich for example, stretching the sheet everywhere, except along the equator, so as to make all the circles of latitude equal in length to the circumference of the equator, and stretching the sheet in the direction of the meridian in the same ratio as the ratio in which the circles of latitude are stretched, while keeping at right angles the intersections between the meridians and the parallels. The sheet thus altered may be laid out flat or rolled up, as a paper chart.

What I call a generalised Mercator's chart for a body of any shape, spherical or non-spherical, is a flat sheet, showing for any intersecting lines that can be drawn on a part of the surface of the body, corresponding lines which intersect at the same angles. One Mercator chart of finite dimensions can only represent a part of the complete surface of a finite body, if the body be simply continuous; that is to say, if it has no hole or tunnel through it. The whole surface of an anchor ring can obviously be mercatorised on one chart. It is easily seen for the case of the globe, that two charts suffice to mercatorise the whole surface; and it will be proved presently that three charts suffice for any simply continuous closed surface, however extremely it may deviate from the spherical form.

In *Liouville's Journal* for 1847, its editor, Liouville, gave an analytical investigation, according to which, if the equation of any surface whatever is given, a set of lines drawn on it can be found to fulfil the condition that the surface can be divided into infinitesimal squares by these lines and the set of lines on the surface which cut them at right angles. Now it is clear that if we have any portion of a curved surface thus divided into infinitesimal square allotments, that is to say, divided into infinitesimal squares with the corners of four squares together, all through it; we can alter all these squares to one size, and lay them down on a flat surface with each in contact with its four original neighbours; and thus the portion of surface given is mercatorised. Except for the case of a figure of revolution, or an ellipsoid, or virtually equivalent cases, Liouville's differential equations are of a very intractable kind. I have only recently noticed that we can solve the problem graphically (with any accuracy desired, if the problem were a practical problem, which it is not) by aid of a voltmeter and a voltaic battery, or other means of producing electric currents, as follows:—

1. Construct the surface to be mercatorised in thin sheet metal of uniform thickness throughout. By thin I mean that the thickness is to be a small fraction of the smallest radius of curvature of any part of the surface.

2. Choose any two points of the surface, N, S, and apply the electrodes of a battery to it at these points.

3. By aid of movable electrodes of the voltmeter trace an equi-potential line, E, as close as may be around one electrode, and another equi-potential line, F, as near as may be around the other electrode. Between these two equi-potentials, E, F, trace a large number, $n$, of equi-different equi-potentials. Divide any one of the equi-potentials into $n$ equal parts, and through the divisional points draw lines cutting the whole series of equi-potentials at right angles. These transverse lines and the equi-potentials divide the whole surface between E and F into infinitesimal squares (Maxwell, "Electricity and Magnetism," section 651).

4. Alter all the squares to one size, and place them together, as explained above. Thus we have a Mercator chart of the whole surface between E and F.

N and S of our generalisation correspond to the north and south poles of Mercator's chart of the world, and our generalised rule shows that a chart fulfilling the essential principle of similarity realised by Mercator may be constructed for a spherical surface by choosing for N, S, any two points not necessarily the poles at the extremities of a diameter. If the points, N, S, are infinitely near one another, the resulting indicator chart for the case of a spherical surface is the stereographic projection of the surface on the tangent plane at the opposite end of the diameter through the point, C, midway between N and S. In this case the equi-potentials and the stream lines are circles on the spherical surface, cutting N, S at right angles, and touching it respectively.

For a spherical or any other surface we may mercatorise any rectangular portion of it, A B C D, bounded by four curves, A B, B C, C D, D A, cutting one another at right angles as follows. Cut this part out of the complete metallic sheet; to two of its opposite edges, A B, D C, for instance, fix infinitely conductive boilers. Apply the electrodes of a voltaic battery to these borders, and trace $n$ equi-different equi-potential lines between A B and D C. Divide any one of these equi-potentials into $n$ equal parts, and through the divisional points draw curves cutting perpendicularly the whole series of equi-potentials. These curves and the equi-potentials divide the whole area into infinitesimal squares. Equalise the squares and lay them together on this flat as above.

If we have no mathematical instruments by which we can draw a system of curves at right angles to a system already drawn, we may dispense with mathematical instruments altogether, and complete the problem of dividing into squares by electrical instruments as follows:—Remove the conducting borders from A B, D C; apply infinitely conductive borders to A B and B C; apply electrodes to these conducting borders, and, as before, draw $n$ equi-different equi-potentials. This second set of equi-potentials and the first set divide the whole area into squares.

## NOTES.

**Ourselves.**—A lithographed letter, of which the following is a copy, has been sent to a number of news-agents who have an extensive sale for the ELECTRICAL REVIEW:—

39, Hatton Garden, London, E.C.
*September 16th*, 1892.

Sir,—Having been consulted by my clients, the Medical Battery Company, Limited, the proprietors of Harness's Electropathic Belts, and also the Electropathic and Zander Institute of 52, Oxford Street, W., with reference to some malicious libels published in ELECTRICAL REVIEW and a paper called *Science Siftings*, I beg to give you notice that if these, or any future publications containing defamatory articles or paragraphs are sold or circulated by your firm, my clients will hold you responsible.

In the same way, you will be held responsible for the exhibition of any libellous bills or placards.

I am, Sir,
Yours obediently,
AUG. FLEET.

We have communicated with all the firms who have, so far, intimated to us that they have been recipients of these intimidating and threatening letters, undertaking to indemnify them for any damages or costs which they may incur through any action on the part of the Medical Battery Company or the Zander Institute with regard to the circulation of the REVIEW. Furthermore, we are taking direct legal proceedings to defend our interests and those of the trade.

**Electric Indicator at Sherborne Water-Works.**—At a meeting of the Sherborne (Dorsetshire) Local Board, last week, the surveyor reported the completion and efficient working of the electric indicator and recording apparatus in connection with the top reservoir and pumping station of the water-works. He felt sure, he added, from the little experience they had had of it, that so much time, coal and wear and tear of the machinery would be saved by possessing it, that the cost would be repaid in a very few years. It was mentioned that about two hours' pumping per diem was also saved.

**The Institution of Engineers and Shipbuilders in Scotland.**—Mr. W. B. Sayers read before this Institution, in February last, a paper on "The Electric Motor," purporting to be "a practical description of the modern dynamo machine, more particularly as a motor." He attempted to steer between the two extremes of treating the subject for specialists, or merely superficially; and, judging from the tone of the criticisms on the paper from the members present, it would appear he signally failed. The paper, which has been reprinted from the *Transactions* of the Institution, is now before us, and is, to our thinking, much more suitable for a Technical College lecture on the theory of electro-dynamics than for a body of professedly practical engineers, who, presumably, collectively have only a working acquaintance with Ohm's law and the electro-magnetic theory. Mr. Sayers made a mistake to give them such a really interesting illustration of the electric motor; a practical paper on work done in Europe and America would have been more suited for his hearers. The proper place for theoretical papers is in technical colleges, or before one of the London societies, where one is always sure of appreciation from at least a part of the audience.

**Fleetwood and the Electric Light.**—At a meeting of the Fleetwood Commissioners, last week, it was decided not to entertain an offer of the Fleetwood Gas Company for the purchase of the works by the town authorities. Four estimates for lighting the town by electricity have been obtained.

**Electric Lighting in Leeds.**—At a meeting of the Highways Committee of the Leeds Corporation, last week, the plans of the Yorkshire House-to-house Electricity Company were submitted and, subject to certain conditions, were approved.

**Cables used by the Clichy Sector Company, Paris.**—We know that the system of cables—insulated by jute under lead and sheathed—used by the Clichy Sector Company, Paris, is very easily laid down. All that has to be done is to open a trench, throw in a layer of sand, lay the cables, and cover them in. We have an instance of the time occupied in laying these cables. Four lengths, of 250 metres each, were laid in three days, of 12 hours each, by a gang of ten workmen. The work of opening and closing the trenches is included in this time.

**Lighting of the Orleans Railway Station, Paris.**—The Orleans Railway Station, Paris, has just been lighted by electricity. The installation comprises two boilers, and two 90 horse-power Corliss condensing engines, working at 75 revolutions per minute. The steam engines drive, by means of belts, Ganz dynamos of 350 volts and 140 amperes, as well as a dynamo of 1,000 volts and 12 amperes. The lighting comprises 120 arc lamps on different systems (Bardon, Pilsen, Thomson-Houston), distributed into 16 circuits of 7 arcs in series, and one circuit comprising a number of variable arcs not exceeding 20.

**F. Henrion's Rapid Interrupter.**—We know how necessary it is to have a rapid interrupter to open and close a circuit suddenly. M. F. Henrion, of Nancy, has just constructed an apparatus of this kind. It consists of two blocks of copper placed facing one another, with an open space between them; a lever moves round an axle, and the whole is fixed on a slate base. The lever bears a folded plate of copper, which is itself formed of a series of little sheets placed one upon another, so as to retain their elasticity. This copper plate is free, and is only held by a rod which passes through the handle. A spring enables it to be drawn back suddenly, so that when the lever is lowered to establish communication it is necessary to press on it a little to get the copper plate back between the two blocks. When we wish to break the circuit we draw back the lever, the spring is tightened, and when the copper plate, which is kept in by force, arrives at the opening, the spring suddenly draws it back. Instruments of this kind have also been constructed for two poles.

**Chelsea Electric Lighting.**—The surveyor to the Chelsea Vestry, in his report for the year 1891-1892, refers to electric lighting matters, and states that the Chelsea Electricity Supply Company is the only company in the district at present keeping records which the vestry's inspector could examine. From time to time he had inspected the records kept by that company, and found that the pressure recorded by their instruments was always above 100 volts—it usually being about an average of 103 volts—except on one or two occasions when alterations were being made to the engines. He considered that their system showed very satisfactory results, and he was of opinion that they kept well within the limits laid down in the Board of Trade regulations. He gives the following interesting statistics regarding the number of houses lighted by electricity in the Chelsea district:—

| | 1889-90 | 1890-91 | 1891-92 |
|---|---|---|---|
| Chelsea Electricity Supply Company... | 113 | 215 | 312 |
| Cadogan Electric Light Company ... | 25 | 16 | 18 |
| London Electric Supply Corporation | 1 | 2 | 2 |
| | 139 | 233 | 332 |

From these figures it will be seen that about 100 houses have adopted electric lighting during each of the last two years.

**Telegrams in France.**—The charge for telegrams is still very high in France. If the latest statistics are to be believed, the amount expended in telegrams addressed to Dahomey by the French Government is estimated at 500,000 francs.

**Electric Accidents at Toulouse.**—During the severe storms that raged at Toulouse at the end of August, the lightning struck several parts of the overhead electric light lines and seriously damaged them.

**Electric Lighting in Paris.**—M. Naze has just opened an office for the receipt of subscriptions for electric lighting along the left bank of the Seine, and a company has been formed for the purpose.

**Paris Underground Conductors.**—In consequence of the severe storms that occurred in Paris at the end of August, the electric canalisations had their trenches filled with water. This caused short circuits in several places. Several lines had to be suppressed for a time until the water in the trenches had been pumped out. Notwithstanding all the joints, the water still penetrates into the trenches in considerable quantities. The municipal administration at Paris is greatly troubled at this state of affairs.

**M. V. Popp's Resignation.**—It is known that M. Popp founded in Paris a company for the distribution of compressed air, and an electric lighting company with the aid of German funds. These companies worked very well for some years, but lately dissensions have arisen. Several German bankers, forming part of the Council of Administration, wished to have their convictions acted upon. M. Popp thought fit to oppose them in the interests of the company. The bankers held out, and M. Popp sent in his resignation. Such are the facts, which we have gathered from the company itself.

**Registering Voltmeter.**—Probably our readers know the ampèremeter and voltmeter of the Hümmel type, constructed by M. F. Henrion, at Nancy. The inventor has conceived the idea of constructing a registering voltmeter of remarkable simplicity. The voltmeter consists in the employment of a solenoid, in the middle of which is attracted an iron palette. On the one side this bears a needle for marking the difference of potential, and at the other extremity is a pencil which is displaced on a cardboard disc impressed with a uniform rotatory movement. The disc is divided into a series of sectors, marking the different hours. The successive differences of potential are shown on concentric circumferences. It is thus very easy to take in at a glance the working of a whole day. It is also very easy to graduate this apparatus. All that has to be done is to trace with the pencil of the voltmeter a series of circumferences corresponding to the successive values of the differences of potential. We must not forget that this apparatus is at the same time a voltmeter and a registering apparatus.

**Low-Tension Street Arc Lighting.**—It is an undeniable fact that low-tension or multiple arc lighting is rapidly becoming more popular. When we see, says the New York *Electrical Engineer*, the tendencies of electric lighting—local incandescent companies and electric railway companies running hundreds and hundreds of such lights on their regular circuits, it is plain that a new and important factor in street lighting must be taken into account. As a matter of fact, a great many of these constant potential arc lamps are used on the streets, but it is still a novel thing that they should be used from end to end of an important thoroughfare. This departure has been taken, however, in the contract made recently by the New York City Gas Commission with the local Edison Company for the lighting of Fifth Avenue from Washington Square all the way to Fifty-Ninth Street. The lights will be in pairs at street intersections, and, of course, will be supplied from the Edison underground mains without the necessity of any overhead wires. A brilliant illumination of this fine avenue is expected in place of the feeble flicker of the old gas lamps, and the experiment will be very closely watched. The influence of its success upon the lighting of leading thoroughfares in large cities must be obvious to all.

**The Electric Light in Glasgow.**—The work of preparing the installation for the lighting of the principal streets of Glasgow with electricity is progressing rapidly. A large number of private firms in the centre of the city are now having their premises prepared, and these firms, says the *Scotsman*, will be supplied by the Corporation.

**Dundalk and Electric Lighting.**—Dundalk was one of the first towns in Ireland to take up electric lighting. This was on account of difficulties with the gas company in the year 1885. The electric lighting proving a failure, however, and the scruples with the gas company being cleared up, the authorities went back to gas. They are now taking steps to once more obtain electric lighting powers.

**"Medal of the First Class."**—We have received from the Harburg India-Rubber Comb Company, of Hamburg, an excellently designed medal made of vulcanite; on the front, the works of the company are in relief; the reverse side containing an imitation form of presentation. The medal was designed by the company as a pleasing way of bringing their wares before the notice of the exhibitors at the Crystal Palace.

**Electrical Transportation of Farm Products.**—Mr. A. Jeffers, writing to the *Scientific American*, states that electricity is being used in the vicinity of Old Point Comfort to take the farm products—cabbages, potatoes, beans, peas, &c.—from the truck farms, near Hampton, to the Government wharf, for local consumption and for shipment north by steamer to New York, Philadelphia, Boston, Baltimore, or Washington. He also states that there are other lines near Norfolk contemplating the same thing. An electric motor placed on a flat car constitutes the locomotive, and other flat cars are attached which are loaded up to their full capacity.

**Underground Telephone Wires.**—According to the *Scientific American*, Prof. A. Graham Bell, speaking of the future of the telephone, says:—"The telephone, as at present constructed, needs the open air to obtain the best results. To use wires placed underground, a metallic circuit will be necessary, similar to the one used now on long distance lines. To place the wires underground and to make a metallic circuit, which means to use two wires where one is used at present, will materially increase the expenses of the company, and the public must pay for the luxury. As the number of wires is increasing rapidly, it is evident that they must ere long be buried."

**Electric Light Accidents.**—According to the *Daily News* an accident recently happened at Königsberg to a workman employed at the town electrical works. He was occupied in fastening some of the conducting wires, when his head must have come in contact with some of the upper wires. He received such a shock that he fell senseless among the net of conductors, and instinctively held on with his hands. They remained hanging so fast that later on they had to be torn loose. His companions believed that he was already dead when they released him, but a doctor who was called succeeded in bringing him back to life. The flesh of the man's left hand was entirely burnt off, and he had received injuries on his face, but it is believed that they will not be fatal.

**Telephonic Progress in India.**—According to current mail advices, considerable progress is being made in India in the setting up of telephone exchanges in the large inland towns. There is very little private enterprise in our Eastern dependency, and it has consequently devolved upon Government to undertake the extension of the benefits of intercommunication by telephone. Those exchanges which already exist are working very satisfactorily, the old instruments which gave a deal of trouble and made subscribers weary of their eccentricities having been replaced by more improved patterns. There have lately arrived from England some specimens of the instruments used by the British Post Office. The Berliner telephone is also being used experimentally, and has given great satisfaction. We believe that in India the telephone will have a great future.

**Bridgend Electric Lighting.**—The Bridgend Local Board have decided to pay a visit to Lynmouth to inspect the lighting of the town, which is effected by electricity. The Bridgend representatives are discussing the adoption of a similar method of lighting their own town.

**Researches in Parallel Circuits.**—In a paper entitled "Forced Harmonic Oscillations of Various Periods," published in the *Philosophical Magazine* for May, 1886, Lord Rayleigh derived analytically expressions for the equivalent resistance and self-induction of parallel circuits in terms of the resistance and self-induction of each branch. It will be profitable to peruse this paper again, and to study it in connection with one which appears in the *Phil. Mag.* for September, by Drs. F. Bedell and A. C. Crehore, of the Cornell University. This paper is entitled "Equivalent resistance, self-induction, and capacity of parallel circuits with harmonic impressed electromotive force." Its object is to obtain by other methods similar expressions for the equivalent resistance, self-induction and capacity of any number of parallel circuits in terms of the resistance, self-induction and capacity of each branch. From these general results, particular expressions for the case of circuits with resistance and capacity alone, and for the case of circuits with resistance and self-induction alone, are readily derived. The results in this latter case were found to be identical with those given by Lord Rayleigh in the paper referred to.

**High Economy Incandescent Lamps.**—It is often said, that as soon as the Edison patent is run out cheap lamps will be available, and that it will pay to run them at very high efficiencies. The orthodox thing to do, says *Industries*, is to assume that the light of a lamp varies as the sixth power of the current, or power—we forget which—and that its life varies inversely as some other power of the same variable. A little equation can then be made, and the best efficiency can be determined in terms of the price of energy and of lamps. This is useless, however, if the efficiency curves taken are found by running a lamp with increasing brightness on the photometer. Most lamps blacken, and also run up in resistance, and this change throws all the calculations out. According to the *Electrotechnische Zeitschrift*, Messrs. Siemens & Halske find that a lamp which originally gave 0·75 candles per watt gives only 0·22 after 55 hours. A 16 candle lamp taking 24 watts runs up in resistance, and blackens so that at the end of 55 hours it gives only 4½ candles. A lamp starting with an efficiency of half a candle per watt falls to 7 candles in 90 hours, and gives only 0·25 candle per watt. A 0·4 candle per watt lamp gives 10 candles after 150 hours at an efficiency of 0·28 candles per watt. The lamp of the future must, therefore, stand a high temperature without blackening, and must not run up in resistance.

**Transformer Chambers in City Churchyards.**—In delivering a somewhat lengthy judgment in the cases of the St. Benet Fink and St. Nicholas Cole Abbey faculties, the Chancellor of London (Dr. Tristram, Q.C.), said: "On Monday, August 29th, application was made to this court to authorise by faculty the construction of transformer chambers or vaults in two city churchyards long disused for burials—one in the churchyard of St. Benet Fink, close to the Royal Exchange, and the other in the churchyard of St. Nicholas Cole Abbey, in Queen Victoria Street—for the use of the City of London Electric Lighting Company, Limited, to enable the company to introduce electric lighting into those parts of the city in which the churchyards are situated . . . . The court is of opinion that it would not be exceeding its jurisdiction in granting the faculties prayed, and that under the exceptional circumstances of these two cases it will be exercising a sound discretion in granting them. It therefore decrees the faculties as prayed—the faculties not to issue within 15 days, and advertisements to be inserted in the *Times* and *City Press*. So as to enable any members of families buried in the vaults to make application to me in chambers relating to their removal, a proviso will be inserted in the faculty permitting the removal of remains, if desired, by members of the families to any consecrated burial ground selected by them. The other remains will be removed to the parochial burial grounds of the respective parishes for reinterment in the consecrated portion of the cemetery."

**Chesterfield and the Electric Light.**—At a recent meeting of the Chesterfield Town Council, it was stated that a large amount of correspondence had been received regarding electric lighting, and the letters would be gone through and reported upon at another meeting.

**Heckmondwike and Electric Lighting.** — At an adjourned meeting of ratepayers held at Heckmondwike on Tuesday last, it was resolved to construct the necessary plant for the lighting of the town by electricity, and application is to be made to the Local Government Board for sanction to borrow the money.

**The Institution of Electrical Engineers.**—We have received from Messrs. Barraud, Limited, a large photograph of "The Members of the Institution of Electrical Engineers." The picture is printed by a permanent auto-carbon process, and is unmistakably a fine specimen of photographic art. A curious feature is that each member was photographed separately, and all were grouped afterwards. The figures of 539 members are arranged in a specially-designed hall, and the complete picture is certainly a masterly exposition of artificial grouping. Although there are many well-known members who do not figure in the photograph, it may be taken as fairly representative of the Institution.

**People's Palace Technical Schools.**—Special courses of instruction in Magnetism and Electricity and Electrical Engineering will be given on Monday, Tuesday, Thursday and Friday evenings, by Mr. W. Slingo, assisted by Mr. A. Brooker, commencing on Monday next. The lectures will be accompanied by practical demonstrations and by work in the laboratory, and special attention given to the principles and practice of electric lighting and instrument making. A course of Practical Workshop Instruction in Brass Finishing and Instrument Making will also be conducted by Mr. Charles Spratt (head foreman in Messrs. Elliot Brothers' instrument works), on Wednesday evenings. The course will be arranged so as to give students a thorough knowledge of the construction of electrical and other scientific instruments.

**For the Alarmists.**—*Apropos* of our recent article on "Incalculable Accidents," the following will be interesting. During the year 1891 every fire that took place in the city of Mineapolis, U.S.A., and which by the remotest possibility could have been due to electricity, was personally investigated by Mr. W. E. J. Deeming. In this city there are upwards of 60,000 incandescent and 2,000 arc lamps in use, to say nothing of motors and street-railway lines, yet only eight fires proved to be remotely or directly connected with electricity, and these together only involved a total monetary loss of less than £5. It is obvious that when we have arrived at perfect wiring and installation, the risk from fire will be nil. And if we have attained such a high degree of safety already, when applied electricity is in its infancy, no apprehension need be felt as to the future.

**Antimony in Electrolytic Copper.**—It appears from some experimental results recently published by W. Hampe in the *Chemiker Zeitung*, that all commercial samples of copper prepared electrolytically, contain small quantities of antimony, ranging from 0·007 to 0·02 per cent. The reason for this is not far to discover, owing to the practice of allowing the sulphuric acid used as the electrolyte in the treatment of argentiferous copper, to circulate again and again through the depositing vat until it becomes comparatively rich in impurities. It is not for us to decide to what extent this trace of foreign metal may prejudice the quality of the electrolytic copper, but we cannot help calling to mind the fact that the influence of traces is one of the most remarkable features in modern metallurgy. Illustrations of this can be found in the cases of steel or of the newer alloys. However, be the influence of antimony in traces upon deposited copper what it may, it is well to know that by taking suitable precautions its amount may be minimised. By frequently renewing the sulphuric acid, the co-precipitation of the antimony may be considerably reduced, although it cannot be entirely avoided.

**Electric Lighting of Romney Marsh.**—The Electric Lighting Committee of the New Romney Corporation are in communication with the manager of the Planet Electric Engineering Company, with a view to the introduction of electric lighting into the borough.

**The Strike at Ponder's End.**—A settlement pleasing to the men has been arrived at in the case of the strike at the Edison and Swan Electric Light Company's works at Ponder's End, under which nearly 60 men came out of the fittings department on September 8th. The manager informed a deputation that an under foreman, against whom the men made charges of bullying and overbearing conduct, was dismissed on the day after the men were called out. The manager said he was not aware that sweating had existed, and it would not have been allowed to exist had he been informed of it.

## NEW COMPANIES REGISTERED.

**Ozone Syndicate, Limited.**—Capital, £25,000 in £5 shares. Objects: To carry on within the United Kingdom the business of ozone producers, sugar refiners, engineers and contractors, manufacturers of sugar refining and other apparatus, and electrical, mechanical, and chemical engineers, and any other business or businesses convenient to be carried on with such businesses, or any branch thereof, and for the purposes aforesaid to acquire lands, works, property, and premises wherever convenient, patent rights, and other property, and to acquire and establish other businesses and property of the nature aforesaid as may seem expedient, and also to carry on the business of builders and contractors, engineers, merchants, importers, &c. Signatories (with 1 share each): John Raworth, 49, Queen Victoria Street, E.C.; B. Broadhurst, 2, Glenthorne Villas, Surbiton, S.W.; W. C. Manns, 19, Upper Kyverdale Road, N.; R. A. Dawburn, Wandsworth; G. B. Mee, 93, Leadenhall Street, E.C.; W. W. Gold, 23, Leadenhall Street, E.C.; J. Hepher, 34, Burney Street, Greenwich, S.E. The regulations of Table A mainly apply. Directors' qualification, £250; remuneration, 10 per cent. (divisible) on the amount distributed in dividends in each year, but no remuneration is to be paid in any year in which dividends to the extent of 5 per cent. are not declared, without the consent of the company in general meeting. Registered on the 15th inst. by Mr. Sydney Morse, 4, Fenchurch Avenue, E.C., solicitor. Registered office, 39, Victoria Street, London, S.W.

**New Electricity Supply Company of Croydon, Limited.**—Capital £40,000 in 7,900 ordinary shares and 100 founders' shares of £5 each respectively. Objects: To establish and maintain at Croydon a central electricity supply station and to supply electricity for the purposes of light or power. Signatories (with one share each): R. Binnie, 8, Forest Road, Forest Gate; D. Pitcairn, 7, New Square, Lincoln's Inn, W.C.; M. Taylor, 11, Southbridge Road, Croydon; E. E. Henderson, 12, Lancaster Place, N.W.; W. F. Taylor, Boswell Court, Croydon; J. W. B. Unwin, 58, Southbridge Road, Croydon; E. E. Harrison, 263, Strand, W.C. The regulations of Table A mainly apply. Registered on the 16th inst. by Messrs. Harrison and Robinson, 263, Strand, W.C., solicitors.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Ruston, Proctor & Company, Limited.**—The annual return of this company, made up to June 14th last, was filed on the 22nd of the same month. The nominal capital is £250,000 in £10 shares. The whole of the shares have been taken up, and £10 called up on 17,500 of the shares. The full amounts have been paid, amounting to £175,000, £75,000 being the total amount agreed to be considered as paid on 7,500 shares. Registered office, The Sheaf Iron Works, Lincoln.

**Madras Electric Tramways Company, Limited.**—The statutory return of this company, made up to July 28th last, was filed on the 9th ult. The nominal capital is £100,000, divided into 100,000 shares of £1 each, or 15 rupees each. 14,400 shares at £1 each, and 6,273 shares at 15 rupees have been taken up. Upon 14,400 shares 5s. has been called, and upon 6,273 shares 4 rupees has been called. The total amount of calls paid in England amount to £3,600, and in India to Rs. 12,546, and unpaid in England to £10,800, and in India to Rs. 75,276. Registered office, No. 1, Trafalgar Buildings, Northumberland Avenue, W.C.

## BUSINESS NOTICES, &c.

**Hanley Electric Lighting.**—*General Supply.*—The following is a condensed summary of the contract with the Brush Electrical Engineering Company:—Four Lancashire boilers, each 28 feet by 7 feet; steam pressure 140 lbs. Five vertical compound condensing engines, viz: three 200 I.H.P. and two 100 I.H.P. at a steam pressure of 120 lbs. Five alternators, viz.: three 100 units, and two 50 units, driven from engines by ropes. Separate vertical engine and dynamos for exciters. Separate compound engine for air and circulating pump and surface condenser. Each alternator, each exciter, and each circuit is equipped with complete switchboard. Primary mains two lines of cast-iron socket pipes, into each of which a concentric cable is drawn from generating station on canal side to the compulsory area, together with a third line of cast-iron pipes for future requirements. Primary ring main of the same character, embracing five transformer points and 15 transformers within the compulsory area. Low tension distributing mains laid throughout the streets scheduled in the compulsory area, comprises a small cast-iron trough with cast-iron lid, with two separate insulated cables embedded therein in bitumen. Total, £13,964.

*Street lighting within compulsory area.*—Contract includes 20 2,000 N.C.P. "Brush" direct current arc lamps and posts, one switchboard, two dynamos, each capable of developing 12,500 watts, two vertical compound steam engines, having cylinders 6 inches and 10 inches, 8 inches stroke. Two miles 640 yards copper conductor, insulated with vulcanised rubber and braided and drawn into wrought iron pipes, with all necessary fittings as specified. Total, £1,796.

Total for general supply and street lighting, £15,760.

*Electric light tenders.*—The following is an abstract of tenders received:

*Schemes utilising canal side for generating station.*

High tension continuous current plant with continuous current transformers to a low tension distribution in the compulsory area.

| | | |
|---|---|---|
| 1. | The Electric Construction Corporation ... | £21,979 |

High tension alternating current plant with transformers on customer's premises.

| | | |
|---|---|---|
| 2. | Messrs. C. A. Parsons & Co. ... ... ... | £19,100 |

High tension alternating current plant with transformers at substations and low tension distribution in the compulsory area.

| | | |
|---|---|---|
| 4. | Messrs. J. G. Statter & Co. ... ... ... | £18,517 |
| 5. | Messrs. J. E. H. Gordon & Co. ... ... | 17,286 |
| 6. | The Laing, Wharton & Down Construction Co. | 15,690 |
| 7. | The Westinghouse Electric Company ... | 14,526 |
| 8. | The Brush Electrical Engineering Company | 13,964 |
| 9. | Messrs. J. B. (? J. D. F.) Andrews & Co. ... | 10,115 |

*Schemes utilising land in Percy Street for the generating station.*

This land is within the compulsory area, and is in the centre of the town. No water for condensing. Coal must be carted.

Low tension continuous current plant with accumulators.

| | | |
|---|---|---|
| 10. | Messrs. Paterson & Cooper ... ... ... | £20,500 |
| 11. | Messrs. Johnson & Phillips ... ... ... | 19,350 |
| 12. | The Electric Construction Corporation ... | 17,514 |
| 13. | Messrs. Sharp & Kent .. ... ... ... | 14,150 |
| 14. | Messrs. Crompton & Co. ... ... ... | 13,000 |

Low tension continuous current plant without accumulators.

| | | |
|---|---|---|
| 15. | Messrs. Siemens Bros. & Co.... ... ... | £15,430 |
| 16. | Manchester Edison-Swan Company... ... | 12,140 |
| 17. | Messrs. Woodhouse & Rawson ... ... | 8,750 |

*Schemes utilising land adjoining Town Yard for the generating station.*

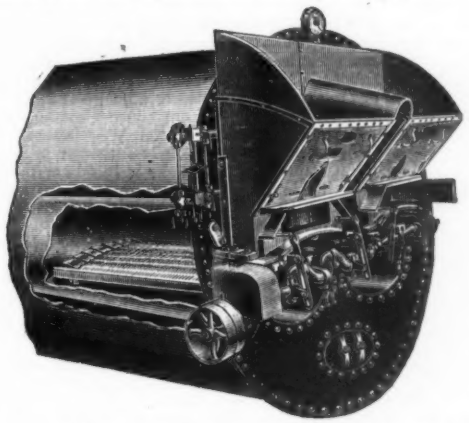
No water for condensing. Coal must be carted.

| | | |
|---|---|---|
| 18. | Messrs. Siemens Bros. & Co. (low tension)... | £18,350 |
| 19. | Messrs. Johnson & Phillips (high tension)... | 17,550 |

All tender for a total output of 400,000 watts, except No. 17, which is for 300,000. The horse-power varies from 450 to 800. All the low tension schemes, except No. 12, are on the three-wire system. Nos. 2, 13, 14, 19, use Willans engines; Nos. 1, 3, 4, 15, 18, use horizontal engines. No. 2 uses the steam turbines coupled direct to alternators. Nos. 1 to 9 are all condensing. No. 3 withholds permission to publish. No. 9 does not include for transformers.

*Street lighting tenders.*—The tenders invited were for 20 arc lamps distributed in the compulsory area. Some tendered for an entirely separate plant; the arc lamps being lighted and extinguished from generating station. Some tendered for alternating current lamps controlled from a transformer station within the area. Some tendered for no separate system at all, but taking the electricity from the nearest general supply cable, and requiring the lamplighter to go round to light up or extinguish. In each of these classes there were variations, some including both arc lamps and posts, some including lamps but not posts, and others excluding both. As no fair comparison could under these circumstances be made, it is not desirable to publish the list of tenders.

**A Circular Furnace Stoker.**—He that makes two blades of grass grow where one formerly grew, is considered a benefactor to mankind. That being so there ought to be much appreciation of the method which makes a direct economy its object. The future development of electricity is entirely wrapped up in the question of economical working of central stations, and apparatus designed with this object is nowadays well considered. A new patent circular furnace stoker, made by the St. Clair Mechanical Stoker Company claims advantages which, at least, ought to merit some trials. The stoker is used in combination with the circular furnace in which the fire naturally falls against the sides of the flue, a very important point,



as it gives—first an intensity of heating power, being in direct contact with the boiler plates; second, this increased depth of fire just where it should be, owing to the more rapid combustion on sides of flue, prevents the inlet of any cold air into the furnace; third, the fire in centre of furnace being raised so much higher gives a greater heating power on top of flue and all round; fourth, more room for cleaning out ashes underneath and less danger to back bridges and bar ends. Owing to this improved shape of furnace the pusher is lengthened considerably, and is thereby worked from the two outside cranks; by this change ample room is secured for a hand-firing door without in any way interfering with the great value of having the pusher the entire width of fire when the door is closed, as when the stoker is at work it requires no hand-firing to help it whatever; and the pigeon cotes can always be used for raking, stirring, or observing the condition of the fire.

**Cox, Robinson & Company.**—An enquiry was held last week in the Liverpool Bankruptcy Court regarding this firm, lately carrying on business at 8, Strand Street, Liverpool, as electrical engineers. The joint statement of affairs showed liabilities £1,627 and assets £873, excluding £42 due to preferential creditors. The sum of £430 was set down as value of patents; £250, stock-in-trade; and £125 book debts. The cause of failure was loss in developing sundry patents. Charles Walter Cox said that the partnership commenced in September, 1887, each partner contributing equally to the stock, working tools, and electrical apparatus valued at £250. He was to find working capital as required by the business, and between 1887 and 1890 paid in about £800. In 1890 they patented an electric invention for advertising purposes called "The Levonia Flashing Letters." An agreement was entered into with the Empire Theatre of Varieties Company, Leicester Square, London, for working a magnetic apparatus in connection with the "show," of which, under agreement, details could not be given. The work had not been concluded. Mr. Neville, solicitor, who appeared for the debtor, did not ask any questions. The inquiry was adjourned.

The following is a list of the creditors:—Shaw, Birkenhead, £14 10s.; Thomas, Birkenhead, £30 15s.; Birkett, Bootle, £13 10s.; McIntyre, J., Burslem, £94; Bell, James, Liverpool, £30; Nixon, Liverpool, £33 5s.; Sadler, I., Liverpool, £100; Sanogen Ventilating Company, Liverpool, £26 10s. 1d.; Taylor, I., Liverpool, £10 8s. 1d.; Thompson, Liverpool, £34; Watts, Liverpool, £34; Edison & Swan, London, £179 7s.; London Electric Corporation, London, £29 17s. 5d.; Sonnenthal, Selig & Co., London, £16 3s. 6d.; Still, Wm., London, £13 8s. 1d.; Woodhouse & Rawson United, Limited, London, £85 4s.; Townend, I., Manchester, £145; Glover, W. T. & Co., Salford, £43 17s. 3d.; Higson, Southport, £31 10s.; Kendrew, Southport, £34 10s.; Hanson & Scott, Stockport, £12 6s. 11d.; and creditors under £10.—Partly Secured Creditor:—Townend, I., Manchester, £300; estimated value of security, £200; other liabilities, £425.—Expected to Rank:—Preferential creditors, £42 2s. 10d.; liabilities, £1,627 19s. 2d.; assets, after deducting preference claims, £873 17s. 2d.—Separate Estate of C. W. Cox:—Bell, J., Liverpool, £50; Liverpool Institute, Liverpool, £12 12s.; Mellor, C., Liverpool, £50; total, £126 6s. 1d.; other liabilities, £200; expected to rank.—Separate Estate of F. G. Robinson:—Sawyer, W., Liverpool, £12 10s.; £18 2s. 6d.

**Cooking by means of Electricity.**—Messrs. Crompton and Co., Limited, are giving close attention to the development of the use of electricity for domestic purposes, including cooking, and in order to bring the advantages of their apparatus before the public, they are showing it at various exhibitions at the present time. The latest exhibit is at the Health Exhibition, Portsmouth. The large range makers and gas stove people competed very closely for the medals awarded by those interested. Messrs. Crompton have been more successful than the majority, by carrying off two prize medals and the highest awards. One was given for the improved electrical cooking apparatus, and the other for improvements in domestic motors, with a new reducing gear applied direct to the motor, thus saving the necessity of bands and pulleys. Messrs. Crompton show a dynamo which drives arc and incandescent lamps for lighting the building, and supplies the current for the cooking apparatus, ventilating fans, &c. The working of the electric kettles, cookers, and hot plates, was watched with great interest by all attending the Congress, and it was acknowledged to be a move in the right direction. Mrs. Knight, the cook employed by the Institute to demonstrate the use of gas and other stoves on trial, prepared food by the electric cookers every day, and proved that the electrical apparatus was not only equal, but superior in many respects to the gas cooking appliances formerly employed. Mr. H. J. Dowsing has been down on several occasions and given short lectures explaining the uses of the various apparatus, and altogether the innovation of competing with the makers of coal ranges and gas stoves has created great interest. We understand that it is the intention to introduce electricity as a sole cooking power in several large flats in the West End of London nearing completion, where it was formerly intended to instal gas stoves. The supply companies will make a special reduction for current used for driving domestic machinery and cooking apparatus, and this will encourage its use, and increase the day demand for electricity. Messrs. Crompton are introducing a number of new applications in the way of electric heating, and their showrooms at 148, Brompton Road will shortly be completed. In the window may now be seen kettles boiling by electricity, and warming apparatus at work, and the large numbers of passers by that stop to look in, prove the interest evinced in the matter. The Health Exhibition at Portsmouth remains open for a further three weeks.

**Gas v. Electricity.**—One of the first gas companies to seriously feel the competition of electricity has been the gas company of Carlow, in Ireland, which Messrs. J. E. H. Gordon & Co., Limited, of 11, Pall Mall, have been lighting for the last 14 months. Week by week more lights have been taken on, and at the present moment nearly one quarter of the total revenue of the gas company has been transferred to Messrs Gordon. One night this week the gas company issued a circular to the inhabitants of Carlow, informing them that any person using electricity would be at once cut off from the gas mains. Immediately on receipt of a copy of this circular Messrs. Gordon telegraphed to the Town Clerk of Carlow, and to their offices in Carlow, as follows:—"Town Clerk, Carlow. Please inform inhabitants whom we hear the gas company are endeavouring to deprive of light, that we are prepared to supply the whole town, and will immediately send over all necessary materials and men to save the town from inconvenience. (Signed) GORDON, London." "To Gordon & Company, Carlow. Use every effort to supply all inhabitants coerced by gas company, and requisition at once for all men and materials required. (Signed) GORDON, London." And a large staff of extra men, and all the necessary materials for wiring the rest of the town and for enlarging the plant are being sent over as rapidly as possible. It is to be hoped that the action of the Carlow Gas Company will be followed by other gas companies, and thus will hasten the final displacement of gas by electricity for the illumination of shops and private houses.

**J. C. Howell, Limited.**—In our issue of September 16th we referred to a plant for pumping, recently started at the Merthyr and Aberdare coal pits. It is there said that the work was done by the "Crompton-Howell Electric Power and Storage Company." The plant in question, however, was not supplied and erected by that company, but by Messrs. J. C. Howell, Limited, of 24, Queen Victoria Street, London, E.C., and New Dock, Llanelly, and is one of a number of similar plants supplied by the same firm, working in a most satisfactory manner—both in South Wales and elsewhere.

**Tenders Wanted. — Burnley.** — Tenders are being invited for the supply and erection of machinery and plant for electricity supply at the central station, and for cables to be laid in the streets, as a whole or in parts, for the Corporation of Burnley, as follows:—1. Steam boilers. 2. Fuel economisers. 3. Steam engines. 4. Travelling cranes. 5. Dynamos. 6. Accumulators. 7. Switchboards. 8. Cables. Specifications and forms of tender may be obtained on application to Mr. J. P. Leather, Gas Works, Burnley. Tenders, on the prescribed form, sealed and endorsed in accordance with above list, must be sent in addressed to the Chairman of the Electric Lighting Sub-Committe, Town Clerk's office, Town Hall, Burnley, by October 26th.

**Tenders Wanted.—Southampton.**—Tenders are invited for the electric lighting of the Corporation water works, Otterbourne, near Shawford, for the Corporation. Specification and form of tender may be had, plans inspected, and all further particulars obtained upon application to Mr. J. G. W. Aldridge, electrical engineer, 9, Victoria Street, Westminster, and at 23, High Street, Southampton. Sealed tenders, endorsed "Tender for electric lighting, Otterbourne," must be left at the office of Mr. R. S. Pearce, Town Clerk, Municipal Offices, Southampton, by 2 p.m. on 27th inst.

**Awards.**—Messrs. W. Wilson & Co., electrical engineers, Water Street Works, Middleton, have obtained a silver medal for their exhibit at the Annual Middleton Agricultural Society's Show.

**Caution.**—Since publishing our recent note to the electrical trades cautioning them against being imposed upon by certain Continental "firms" making it their business to order goods from England without paying for them, we have received voluminous information, adding weighty evidence to that already before us, proving beyond doubt the necessity for manufacturers and others to be on the alert for such offenders, by insisting on receiving substantial references before opening accounts. Our caution, we are glad to say, has been the means of saving a number of firms much loss and annoyance. The latest information to hand regarding the Amsterdam firm in question comes from a provincial company. This company, upon receiving an order for certain goods, referred it back for references, and in reply to that communication were given the name of a Netherlands bank. This being insufficient, they conferred with their own bankers, from whom they had a very unfavourable report anent their intending clients. Thereupon they once more wrote to Amsterdam, making a further reasonable request, but an answer came, in very mutilated English, to the effect that it was their custom to examine all goods before paying for them, and as they had no connection with England, the order must be cancelled. Further caution we consider unnecessary, but for easy identification of correspondence from the particular house, we may mention that all the letters and postcards we have seen up to the present have been typewritten, and in very bad English.

**The Electric Lighting in the City.**—There is a continuous rapid development of the adoption of the electric light in the City. Notwithstanding the long list of installations which we recently published, we have still a further number to report upon this week. Among the installations at present in hand, we may state that Messrs. Lund Bros. & Co., of 355, Oxford Street, have the contract for the installation at the Guildhall.—Messrs. Strode & Co., of St. Paul's Churchyard, E.C., are fitting up the premises of the Alliance Life and Fire Office, Bartholomew Lane.—The Electrical Supplies and Fittings Co., of Charing Cross Road, W.C., are fitting up the premises of the Alliance Marine and General Assurance Company, Capel Court, Bartholomew Lane.—Messrs. Rashleigh Phipps and Dawson, of Berners Street, W., are fitting up the premises of Messrs. Hill & Sons, confectioners, Bishopsgate Street.—Messrs. Laing, Wharton & Down, of New Bond Steeet, are fitting up the premises—now undergoing alterations—of Messrs. Hobson & Sons, Gracechurch Street, while Messrs. D. Hulett & Co., of Holborn, W.C., are fitting up the premises of the National Provident Institution, Gracechurch Street.

**Electric Light at the Alhambra.**—The partial reconstruction of the Alhambra, which is just completed, involved relighting and redecorating. In redecorating the grand lounge and stalls, the Alhambresque style has been somewhat intentionally disregarded, in order to get a lighter and more elegant effect. The whole of the decorative tone is therefore kept cream, white, and gold, with a little grey blue to relieve it. The theatre has been recarpeted and upholstered in colours and material to suit the general scheme, and a complete system of electric lighting, including entirely new plant and fittings, has been carried out by Messrs. B. Verity & Sons. Electroliers of special design have been placed round the balcony fronts, and upwards of 120 new electric lamps have been fitted in front of the mirrors in the grand circle and stalls. The electroliers are made in hammered metal, finished in silver and gold ormolu, and the designs are the same as recently supplied to an Indian palace for a late well-known Viceroy. The generating plant consists of gas engines and Elwell-Parker dynamos, the use of steam power being impracticable owing to want of space.

**Drake & Gorham's Catalogue.** — A new catalogue, nicely printed on good paper and neatly and securely bound in a new style of binding, has been brought out by Messrs. Drake & Gorham. A large number of illustrations are given, chiefly of small fittings, batteries, switches, switchboards, battery testers, voltmeters, lamps and lampholders. In addition to prices and particulars of these articles, we also notice some useful information regarding the most judicious way of arranging installations, and two full page cuts appear for the purpose of illustrating what is said on this important point. All sizes of continuous current dynamos are priced and particularised. Considering the smallness of the book, which consists of only 50 pages, a vast amount of information is very readably put together; there is no attempt, at what is a great mistake made in many catalogues, *i.e.*, overcrowding of useful matter. It is evident that Messrs. Drake & Gorham have taken great pains, and gone to considerable expense in preparing this book.

**Defalcations of a Company's Secretary.**—On Wednesday last, at the Mansion House, William Bundy was charged on remand, before the Lord Mayor, with forgery. The prisoner was secretary to Messrs. R. C. Cutting, Douglas & Company, Limited, electrical engineers, Wardrobe Chambers. It was part of his duty to fill up cheques, and obtain the signatures of the directors to them. It was alleged that, having the cheque books and other documents in his possession, he forged the names of two directors—Messrs. Heale and Douglas—to cheques for £6 and £2 8s. 9d., for which he obtained payment at the City Bank. The prisoner said he had a right to use the names of the two directors in question. The Lord Mayor committed him for trial.

**Electric Lighting of Coatbridge.**—Messrs. J. E. H. Gordon & Company, Limited, have obtained a contract for the electric lighting of Coatbridge, and are proceeding to erect a station of 9,000 lights capacity, with all the necessary street mains. The machinery is in hand, and it is expected that the work will be finished in the early spring.

**Garden Party Illuminations.**—A very successful temporary installation of the electric light was carried out by Messrs. Rawlings Bros., of 82, Gloucester Road, S.W., on Thursday, last week, the occasion being a garden party given by Wm. Burdett-Coutts, Esq., M.P., at Holly Lodge, Highgate. The lighting was effected by incandescent lamps run off Epstein accumulators, type X, three cells, consisting only of one positive and two negative electrodes, and which, owing to the small space they take up, their large storage capacity, and almost unlimited range of discharge, are admirably adapted for such purposes.

**Electric Lighting of Windsor.**—A contract has been signed between Messrs. J. E. H. Gordon & Co., Limited, and the Windsor and Eton Electric Company for the erection of an electric light station at Windsor, and for the running of mains along the High Street and a portion of Pescod Street. The work has already been put in hand, and it is expected that the light will be supplied before Christmas next. The installation is only a small pioneer work, but arrangements are made for a large extension as soon as the success of the first instalment has been demonstrated.

**Change of Address.**—The offices of the New Telephone Company, Limited, will be removed on the 29th inst. from 110, Cannon Street, to the Telephone Exchange, 58 and 59, London Wall, E.C.

**Rashleigh Phipps and Dawson.**—Messrs. Rashleigh Phipps and Dawson have just completed what is said to be the first complete electric plant job in Highbury, namely, the house of Mr. F. A. Donnison, 29, Aberdeen Park.

**The Westminster Electric Supply Corporation, Limited.**—We understand that on and after September 22nd, 1892, the head offices of this corporation will be removed to the central station at Eccleston Place (Eccleston Street), Belgravia, S.W.

**Porcelain Cable Suspender.**—Messrs. Fawcus & Cowan have made Messrs. Bullers, Limited, of 32 and 33, Queen Street, London, sole licensees to manufacture and sell their patent porcelain cable suspender.

## CITY NOTES.

### Direct Spanish Telegraph Company.

THE 38th ordinary general meeting of this company was held on Tuesday last, at Winchester House, Sir James Anderson presiding.

In moving the adoption of the report the chairman stated that at the meeting last March he called attention to the reduction in their tariff—inflicted on them by the Telegraph Conference—of ½d. per word, and stated that if the traffic did not increase, their loss would be £1,760. On the same occasion, however, he was in a position to say that the growth of the Spanish traffic which had resulted from the commercial treaty with Spain in 1886 had continued every year since. In the half-year ended June 30th last there had been an increase of 10,000 telegrams compared with 7,900 in the corresponding period of the previous year, or 130,000 words as compared with 43,000 last year. He was obliged to say this was not all the result of normal growth, as the merchants using their lines had done so very freely with the object of getting their goods into Spain before the treaty expired last June. Still, various causes seemed to force merchants into the use of the telegraph, and once they became accustomed to carrying on their business by telegraphy they did not easily fall back upon the old method of letter-writing. He hoped that that view was the correct one, because it was the mainstay of their revenue. There was never much good in abnormal events, which stimulated telegraphy for a time, with the result of shrinkage, depreciated currency, and a good deal of bankruptcy. Telegraphy, in his opinion, did best when the business pendulum swung both ways with a profitable result. Of course, he did not know whether they were now in this safe position. It was enough to know that since the treaty expired on June 30th, the growth of their traffic was still on the increase. The reduction in the length of the messages by codifying had ceased, and they were one word per message better than they were a few years ago, when there seemed no end to the ingenuity of code-makers. He thought they must let the future take care of itself without attempting to prophesy. Three minutes to Bilbao and 20 minutes to Madrid for a telegraph message came as near dealing with one's foreign correspondent in the same room as could be desired. There had been no expenditure upon repairs in the past half-year. At their last meeting he stated that the directors looked forward to replacing out of future profits the £2,376 which they took from the reserve fund for the repair of their Bilbao cable, and that their opinion was that they should not pay more than 4 per cent., or even less if need be, until this had been accomplished. The contingency fund had also had to be expended. They were now looking forward to renewing their 6 per cent. debentures at a lower rate in 1894, but this would greatly depend upon their reinstating their reserves out of profit, and even providing another contingency fund. He did not take a gloomy view of their prospects, but much depended upon freedom from breaks and expensive repairs. He had made this statement as showing them the policy the directors desired to pursue—a policy which, if carried out, would maintain their shares as a good investment with as little fluctuation as one saw among the better securities in the list of the London Stock Exchange. They were making a very fair revenue, with which they must be satisfied. He had no idea what might happen at the next Telegraph Conference, which, however, he was happy to say, was three years off. There was some talk—and he hoped it was only talk—of a uniform Continental tariff, but he thought that a good many Governments were losing by their telegraphs, and the Governments of the Australian colonies wanted to increase the tariffs. He hardly expected that there would be any great desire to lower the tariff, as it would not pay.

Mr. EDMUND ETLINGER seconded the motion, which was unanimously adopted.

The resolution declaring dividends at the rate of 10 per cent. per annum on the preference shares, and at the rate of 4 per cent. per annum on the ordinary shares, was then proposed by the CHAIRMAN and seconded by Mr. ETLINGER.

### Société Générale des Téléphones.

THE French Government having taken over the working of this company's telephone line, the company now carries on only the manufacture of apparatus and submarine cables, in which English manufacturers find it a dangerous rival. It has, however, a large share in the French Submarine Telegraph Company, and finished on December 31st last the laying of 4,400 kilometres of cable for that company. Another important work undertaken this year by the company was the laying of the Marseilles-Oran cable, 630 miles in length. On receipt of that order the company, to complete its stock, bought the cable ship *Westmeath*, which was formerly known as the *Francois Arago*. The working profits added to the balance from 1890, &c., give a sum of 2,303,352 francs, which, after deducting 323,312 francs for management and other expenses, permits of 822,182 francs being carried to the amortisation account, and leaves an available balance of 1,157,858 francs, which allows of the payment of a dividend to the shareholders of 20 francs per share, of carrying over to the legal reserve of 53,911 francs, and of adding to this year's (1892) figures the balance, or 103,947 francs. The following are the balance-sheets of December 31st, 1891 and 1890, respectively:—

ASSETS.

| | 1891. Francs. | 1890. Francs. |
|---|---|---|
| Cost of first establishment ... ... ... | 29,605,060 | 28,733,286 |
| Industrial participation ... ... ... | 6,306,824 | 6,266,776 |
| Furniture, &c. ... ... ... ... | 44,438 | 49,627 |
| Shareholders ... ... ... ... ... | 3,450 | 6,700 |
| Raw material and stocks ... ... ... | 5,818,166 | 6,826,208 |
| Various debtors, order accounts, and securities ... ... ... ... ... | 4,774,176 | 4,081,626 |
| Rents paid in advance ... ... ... | 22,900 | 54,735 |
| Cash in hand... ... ... ... ... | 1,114,476 | 851,909 |
| | 47,689,490 | 46,867,867 |

LIABILITIES.

| | | |
|---|---|---|
| Capital ... ... ... ... ... ... | 25,000,000 | 25,000,000 |
| Reserve and amortisations ... ... ... | 8,767,059 | 7,917,551 |
| Sum received from the State on account of the value of the telephone lines ... | 5,000,000 | ... |
| Various creditors and order account ... | 5,746,523 | 5,236,396 |
| Coupons to be paid ... ... ... ... | 2,018,050 | 6,023,095 |
| Sum due to the State in compensation for the price of the purchase of the telephone lines. | ... | 1,678,126 |
| Profits... ... ... ... ... ... | 1,158,868 | 1,012,699 |
| | 47,689,490 | 46,867,867 |

As stated above, the dividend last year was 20 francs per share, while in 1890 it was only 18 francs.

**Eastern Extension, Australasia, and China Telegraph Company, Limited.**—The directors have declared an interim dividend for the quarter ended June 30th of 2s. 6d. per share, free of income tax, payable on October 15th prox. The share register will be closed from October 7th to October 14th, both days inclusive.

**Globe Telegraph and Trust.**—An interim dividend of 1s. 9d. per share has been declared by the board, payable on the 18th prox.

## TRAFFIC RECEIPTS.

**The City and South London Railway Company.** The receipts for the week ending September 18th, 1892, amounted to £744; corresponding month, 1891, £684, increase £60; total receipts to date, 1892, £9,203; corresponding period, 1891, £8,418; increase £785.

**The Western and Brazilian Telegraph Company, Limited.** The receipts for the week ending September 16th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £3,584.

## SHARE LIST OF ELECTRICAL COMPANIES.

| Present Issue. | Name. | Stock or Share. | Closing Quotation September 15th. | Closing Quotation, September 22nd. | Business done during week ending September 22nd, 1892. Highest. | Lowest. |
|---|---|---|---|---|---|---|
| 250,000£ | African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer | 100 | 100—103 | 100 — 103 | ... | ... |
| 1,247,720£ | Anglo-American Telegraph, Limited ... ... ... ... ... ... | Stock | 48 — 49 | 48 — 49 | ... | ... |
| 2,876,140' | Do. do. 6 p. c. Preferred ... ... ... ... ... ... | Stock | 89 — 90 | 89 — 90 | 89⅜ | 89 |
| 2,876,140£ | Do. do. Deferred ... ... ... ... ... ... | Stock | 10 — 10½ | 9⅞ — 10⅛ | 10⅛ | 10 |
| 130,000 | Brazilian Submarine Telegraph, Limited ... ... ... ... | 10 | 11¼ — 11⅜ | 11¼ — 11⅜ | 11 9/16 | 11⅜ |
| 53,200£ | Do. do. 5 p. c. Bonds ... ... ... ... ... | 100 | 100 —103 | 100 —103 | ... | ... |
| 75,000£ | Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ... | 100 | 103 —107 | 103 —107 | ... | ... |
| 77,978 | Brush Electrical Engineering Ordinary, Nos. 1 to 63,416 ... ... | 3 | 3⅛ — 3⅜ | 3⅛ — 3⅜ | ... | ... |
| 75,000 | Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416 | 2 | 2⅛ — 2⅜ | 2⅛ — 2⅜ | 2 5/16 | ... |
| 40,000 | Chili Telephone, Limited, Nos. 1 to 40,000 ... ... ... ... | 5 | 3 — 4 | 3 — 4 | ... | ... |
| 50,000 | City and South London Railway, Nos. 1 to 50,000 ... ... .. | 10 | 2½ — 3½ | 2½ — 3½ | 2⅞ | 2⅝ |
| 30,152 | City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152 ... | 10 | 10½ — 11 | 10⅝ — 11⅛ | 11⅛ | 10⅞ |
| 87,710,000 | Commercial Cable, Capital Stock ... ... ... ... ... | $100 | 155 —165xd | 155 —165xd | ... | ... |
| 224,850 | Consolidated Telephone Construction and Maintenance, Limited .. | 14/- | ⅛ — ⅜ | ⅛ — ⅜ | ... | ... |
| 20,000 | Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos 1 to 20,000 | 5 | 5½ — 5⅝ | 5¼ — 5⅜ | ... | ... |
| 16,000 | Cuba Telegraph, Limited ... ... ... ... ... ... | 10 | 11 — 12 | 11 — 12 | 11⅞ | 11⅝ |
| 6,000 | Do. do. 10 p. c. Preference ... ... ... ... | 10 | 17 — 18 | 17 — 18 | 18 | ... |
| 12,931 | Direct Spanish Telegraph, Limited, ... ... (£4 only paid) | 5 | 3½ — 3⅝ | 3½ — 3⅝ | ... | ... |
| 6,000 | Do. do. 10 p. c. Preference ... ... ... | 5 | 9 — 10 | 9 — 10 | ... | ... |
| 60,710 | Direct United States Cable, Limited, 1877 ... ... ... .. | 20 | 11⅛ — 11⅜ | 11⅛ — 11⅜ | 11⅜ | 11 1/16 |
| 400,000 | Eastern Telegraph, Limited, Nos. 1 to 400,000 ... ... ... | 10 | 14⅝ — 15⅛ | 14⅝ — 15⅛ | 15⅛ | 14⅞ |
| 70,000 | Do. 6 p. c. Preference ... ... ... ... | 10 | 15½ — 16 | 15½ — 16 | 16 | ... |
| 200,000£ | Do. 5 p. c. Debs. (1879 issue), repay. August, 1899 | 100 | 106 —109 | 106 —109 | ... | ... |
| 1,200,000£ | Do. 4 p. c. Mortgage Debenture Stock ... ... | Stock | 110 —113 | 110 —113 | 112 | ... |
| 250,000 | Eastern Extension, Australasia and China Telegraph, Limited ... | 10 | 15 — 15¼ | 15 — 15¼ | 15¼ | 15 1/16 |
| 70,000£ | Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 | 100 | 103 —106 | 1 3 —106 | 104⅜ | ... |
| 250,200£ | Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ... | 100 | 103 —106 | 103 —106 | ... | ... |
| 320,000£ | Do. 4 p. c. Debenture Stock ... ... ... ... ... | Stock | 108 —111 | 109 —112 | ... | ... |
| 122,400£ | Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 | 100 | 103 —106 | 103 —106 | 105¼ | ... |
| 162,700£ | Do. do. do. to bearer, Nos. 2,344 to 5,500 | ... | 103 —106 | 103 —106 | ... | ... |
| 300,000£ | Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909 | 100 | 103 —106 | 103 —106 | ... | ... |
| 45,000 | Electric Construction, Limited, Nos. 101 to 45,100 ... ... ... | 10 | 4½ — 5 | 4½ — 5 | ... | ... |
| 19,900 | *Electricity Supply Co. of Spain, Nos. 101 to 20,000 ... ... ... | 5 | ... .. | ... ... | ... | ... |
| 100,000 | Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750 | 2 | ⅜ — ⅝ | ⅝ — ⅞ | ⅝ | ⅜ |
| 82,395 | Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ... | 2 | 2⅛ — 2⅜ | 2⅜ — 2⅝ | 2⅜ | 2 5/16 |
| 67,385 | Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd, | 2 | 1⅛ — 1⅜ | 1⅛ — 1⅜ | ... | ... |
| 20,000 | Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid) | 5 | 2 — 3 | 2 — 3 | ... | ... |
| 180,227 | Globe Telegraph and Trust, Limited ... ... ... ... ... | 10 | 10½ — 10⅝ | 10½ — 10⅝ | 10⅝ | 10⅛ |
| 180,042 | Do. do. 6 p. c. Preference ... ... ... | 10 | 15⅜ — 15⅝ | 15⅜ — 15⅝ | 15 9/16 | 15 1/16 |
| 150,000 | Great Northern Tel. Company of Copenhagen ... ... ... | 10 | 18½ — 19 | 18½ — 19 | 19 | 18⅝ |
| 210,000£ | Do. do. 5 p. c. Debs. (issue of 1883) ... | 100 | 105 —108 | 105 —108 | ... | ... |
| 12,134£ | Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ... | 10 | 5½ — 6½ | 5½ — 6½ | ... | ... |
| 9,600£ | Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000 | 10 | 9½ — 10½ | 9½ — 10½ | ... | ... |
| 50,000 | India-Rubber, Gutta Percha and Telegraph Works, Limited .. | 10 | 21½ — 22½ | 21½ — 22½ | 22½ | 21⅞ |
| 200,000£ | Do. do. 4½ p. c., Deb., 1896 ... ... ... | 100 | 104 —106 | 104 —106 | 104⅜ | ... |
| 17,000 | Indo-European Telegraph, Limited ... ... ... ... ... | 25 | 42 — 44 | 42 — 44 | 43½ | ... |
| 11,334 | International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 ... ... | 10 | 2½ — 3½ | 2½ — 3½ | ... | ... |
| 11,334 | Do. do. Preference Nos. 5,667 to 17,000 ... | 10 | 6 — 7 | 6 — 7 | ... | ... |
| 30,000 | †Liverpool Electric Supply, £3 paid ... ... ... ... ... | 5 | 3 7/16 — 3 9/16 | 3 7/16 — 3 9/16 | ... | ... |
| 10,000 | Do. do. fully paid ... ... ... ... | 5 | 5 5/16 — 5 7/16 | 5 5/16 — 5 7/16 | 5⅛ | 4⅞ |
| 38,348 | London Platino-Brazilian Telegraph, Limited ... ... .. | 10 | 6 — 7 | 6 — 7 | ... | ... |
| 100,000£ | Do. do. do. 6 p. c. Debentures ... ... | 100 | 105 —108 | 105 —108 | ... | ... |
| 49,900 | *Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid) | 10 | 6½ — 7 | 6½ — 7 | 6⅞ | 6½ |
| 50,000£ | Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40 | ... | 102 —105 | 102 —105 | ... | ... |
| 447,234 | National Telephone, Limited, Nos. 1. to 438,984 ... ... ... | 5 | 4⅜ — 5 | 4⅜ — 4⅝ | 4⅜ | 4⅜ |
| 15,000 | Do. 6 p. c. Cum., 1st Preference ... ... ... | 10 | 13⅞ — 14¼ | 13⅞ — 14¼ | 14¼ | ... |
| 15,000 | Do. 6. p. c. Cum. 2nd Preference ... ... ... | 10 | 13¼ — 13¾ | 13¼ — 13¾ | 13 9/16 | 13⅜ |
| 726,477£ | Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ... | ... | 109 —111 | 110 —112 | 111½ | 110⅛ |
| 48,700 | New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid) | 10 | 1¼ — 1⅜ | 1 — 1⅛ | 1⅜ | 1⅛ |
| 6,318 | Notting Hill Electric Lighting Company, Limited, fully paid ... | 10 | 4 — 4½ | 4 — 4½ | ... | ... |
| 220,000 | Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid) | 1 | 1/16 — 3/16 | 1/16 — 3/16 | ... | ... |
| 10,602 | Reuter's Limited ... ... ... ... ... ... ... | 8 | 7 — 8 | 7 — 8 | 7⅛ | ... |
| 15,080 | St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780 | 5 | 7⅞ — 8¼ | 7⅞ — 8¼ | 8¼ | ... |
| 20,000 | Do. do. 7 per cent. pref., Nos. 20,081 to 40,080 | 5 | 8 — 8⅛ | 8 — 8⅛ | 8 1/16 | 8⅜ |
| 3,381 | Submarine Cables Trust ... ... ... ... ... ... | Cert. | 116 —121 | 116 —121 | 117⅛ | ... |
| 78,949 | Swan United Electric Light, Limited ... ... (£3½ only paid) | 5 | 3½ — 4 | 3½ — 4 | 3⅞ | 3⅞ |
| 37,350 | Telegraph Construction and Maintenance, Limited ... ... ... | 12 | 43 — 45 | 43 — 45 | ... | ... |
| 150,000£ | Do do. do. 5 p. c. Bonds, red. 1894 | 100 | 103 —106 | 103 —106 | ... | ... |
| 58,000 | United River Plate Telephone, Limited ... ... ... ... | 5 | 1 — 2 | 1 — 2 | ... | ... |
| 146,370£ | Do. do. 5 p. c. Debenture Stock ... | Stock | 85 — 95 | 85 — 95 | ... | ... |
| 15,009 | West African Telegraph, Limited, Nos. 7,501 to 23,109 ... .. | 10 | 6½ — 7½ | 6½ — 7½ | ... | ... |
| 271,400£ | Do. do. do. 5 p. c. Debentures ... .. | 100 | 100 —103 | 100 —103 | 102 | 100½ |
| 30,000 | West Coast of America Telegraph, Limited ... ... ... ... | 10 | 3 — 4 | 3 — 4 | ... | ... |
| 150,000£ | Do. do. do. 5 p. c. Debs., repayable 1902 ... | 100 | 102 —106 | 102 —106 | ... | ... |
| 64,242 | Western and Brazilian Telegraph, Limited ... ... ... ... | 15 | 9 — 9½ | 9 — 9½ | 9½ | 9 |
| 33,129 | Do. do. do. 5 p. c. Cum. Preferred ... ... | 7½ | 6¼ — 6⅜ | 6¼ — 6⅜ | 6⅜ | 6 1/16 |
| 33,129 | Do. do. do. 5 p. c. Deferred ... ... ... | 7½ | 2⅞ — 3⅛ | 2⅞ — 3⅛ | 2⅞ | ... |
| 124,100 | Do. do. do. 6 p. c. Debentures "A," 1910 ... | 100 | 103 —106 | 103 —106 | ... | ... |
| 230,100£ | Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910 | 100 | 103 —106 | 103 —106 | ... | ... |
| 66,321 | West India and Panama Telegraph, Limited ... ... ... | 10 | 1 — 1¼ | 1 — 1¼ | 1⅛ | 1 1/16 |
| 34,563 | Do. do. do. 6 p. c. 1st Preference ... | 10 | 9¼ — 9⅜ | 9¼ — 9⅜ | 9 1/16 | 9 1/16 |
| 4,669 | Do. do do. 6 p. c. 2nd Preference ... | 10 | 8 — 9 | 8 — 9 | ... | ... |
| 80,000£ | Do. do. 5 per cent debentures (1917) No. 1 to 1,000 | 100 | 101 —105 | 103 —106 | 104 | 103⅜ |
| $1,536,000 | Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds | $1,000 | 123 —128 | 123 —128 | ... | ... |
| 171,000£ | Do. do. 6 p. c. Sterling Bonds ... ... ... | 100 | 97 —102 | 97 —102 | ... | ... |
| 59,900 | Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ... | 5 | 6 — 6½ | 6 — 6½ | 6¼ | ... |

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892).

**LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:**—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7⅜—7⅝.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3⅛.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅜—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20⅛.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 86—90.—House to House Company (£5 paid) 2⅛—3⅛.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅛—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid, 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2¼—3.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

## THE ELECTRICAL WORKS AT WEIZ (STYRIA, AUSTRIA).

[FROM OUR OWN CORRESPONDENT.]

To the north of Weiz, behind the Sturmberg ruin, well known to tourists, which once commanded the exit from the Weiz valley, there lie in the bottom of the valley, close to the Weizbach, two powerful springs which, to judge from the quality of the water, are probably fed from the drainage of the surrounding limestone mountains. These springs, one of which is situated more to the south, the so-called Baumuller spring, is noteworthy for its quantity of water, and yields even in dry seasons from 350 to 400 litres per second. They are distinguished by uniform flow, which even in the severest winter does not fall below the temperature of 8° C. On this account the Weizbach, the more northern course of which is through the wild, romantic Klamm, shows a strong formation of ice, but after the influx of the two springs just mentioned, it remains perfectly free from ice, and has not even its margins frozen. It retains this peculiarity until it joins the Raab, at St. Ruprecht. This characteristic taken in conjunction with its nearly constant uniform volume of water, the rapid fall, and the rarity of floods (among which the catastrophe of last year forms an exception without a parallel for the last century), gives the Weizbach an inestimable value as a source of power for installations of hydraulic force. It has a uniformity quite equal to that of steam power, with much higher economy both in the installation and in working expenses. To this circumstance must be ascribed the early utilisation of the stream in question, which even in the Middle Ages rendered Market Weiz (the town is in some parts of the original spoken of as Market Weiz, and in others merely as Weiz) one of the most industrial places in verdant Styria.

These properties render the stream especially suitable as a source of power for an electric light installation, for which, as it is well known, uniformity of motive power is absolutely necessary.

Franz Pichler, an engineer, and a native of Weiz, who had been familiar from his youth with the local water conditions, and had, as far back as 1886-1887, projected and carried out enlarged water power installation for his father's mill, and on this occasion had made numerous measurements of the Weizbach, drew attention to this circumstance.

The Market community of Weiz was too much involved financially, owing to its participation in the construction of the local Gleisdorf-Weiz railway, and by the needful introduction of new watercourses from elevated springs, to introduce the electric light on its own account. Meanwhile, the engineer studied the affair more closely, and ascertained that with cheap water power, a rational execution of the installation on the proprietor's own account, and especially the construction of the electrical machines and apparatus in the workshops of Schlacher's machine works and iron foundry, and charging prices which would permit the introduction of the electric light into all private houses, the erection and management of electric works for Market Weiz would be remunerative as a private undertaking, and he resolved, accordingly, to carry out the installation.

The community of Weiz met the undertaker so far as to place the streets and open spaces at his disposal gratis for laying down the electric leads and guaranteeing the introduction of electric street-lighting on the conditions to be subsequently enumerated. Thus the undertaker obtained a certain, although small, basis for his receipts.

Pichler considered that the most convenient extent of the declivity of the Weisbach is that between the so-called Baumühle in Offenthal, and the sawmills of Franz Mack in Birchbaum, since only a single right of water-power, *i.e.*, that of the so-called Fladover Mill at the foot of the Sturmberg, would have to be bought up. The absolute fall in this extent of the stream amounts to 17·8 metres, which, on including the ring-fall in the canal of the works, taking as a basis a flow of 0·75 cubic metres at the lowest level of the stream, and a useful effect of 75 per cent. corresponds to 125 horse-power, which value will scarcely be reduced even in the driest weather. The projects were elaborated in the winter of 1890-91, and submitted in the beginning of April last year to the political authorities in order to obtain a concession. A variety of circumstances delayed the meeting of the building commission until October 17th, last year. Although it was only possible to begin with the building after permission had been given by the commission, the operator succeeded in completing the foundations as well as the rough masonry before the occurrence of severe frost.

The installation for water power has been carried out as follows :—About 120 metres below the Baümuhle a weir of small height is built into the stream for the purpose of guarding against floods. Immediately above this weir a canal leads the water to the machine house. This canal is chiefly an earth work, but in passing the Sturmberg and on the Landscha slopes large masses of rock had to be removed. On trial it was found that the sides of the canal were not sufficiently water-tight and they had to be coated with concrete and masonry set in cement. The section of the water in the earth cutting is 1·7 square metre, in the parts blasted through the rocks 1·3 square metre. The upper part of the canal ends at the machine house, which was built near the Landscha quarries. Of the two sluices one serves to regulate the level of the water and to let off the overflow ; the second sluice covers the entrance to the turbine pipe. This having an internal diameter of 80 centimetres leads the water to the turbine. It is executed with Hähnel's back paddles and is built for 125 H.P. It was obtained from the works of Ganz & Co., of Budapest, since there was no time to complete the requisite models at the Weiz machine works.

The undertaker at first proposed to separate the falls in two parts and to utilise them by overshot water-wheels. The plan of setting up turbines was only agreed on in November last. The turbine by means of a couple of wheels drives a horizontal shaft from which the dynamos are driven by means of belting.

The central station contains a large 8-polar dynamo with a drum armature for a maximum yield of 72,000 watts at a tension of 80 volts, excited by a small continuous current dynamo. The alternating currents produced are conveyed to the switchboard upon three massive copper rails, passing the current and tension meters and arriving then at the large station transformer which raises them to the tension of 2,000 volts. Not until here is it dangerous to touch the lead, which is made perfectly inaccessible, and does not require any manipulation whilst in action. All the machines and apparatus are enclosed in a spacious machine hall, 10 metres square, and forming the machine house along with the turbine room, and the residence of the machinist.

The main lead into Market Weiz consists of three wires of the purest copper, each 4·5 millimetres in diameter. They are elevated 6 metres above the ground, carried upon oil insulators (Johnson & Phillips's system), as are also all branches which convey high tension currents. On the same poles is supported a double telephonic circuit, for communication between the house of the undertaker and the machine house.

Branch mains serve to supply the neighbouring hamlets Weizberg and Wegscheid, and the machinery works at Preding.

The transformers for distribution are placed as near as possible to the places of consumption, and they are suspended from the conduction posts in cast-iron boxes. They reduce the working tension from 2,000 volts to the lamp tension of 110 volts, which is perfectly safe, and can be introduced into the houses.

The introduction of high tension leads into houses, and the location of the transformers indoors, as it is practised in many installations, has been entirely avoided on account of the danger. There are at present eight distributive transformers for each 60 lamps, and two of them are set up for each 25 lamps. Their number will be increased as required. The total number of lamps fitted up is 460, in 35 houses, and 150 more are ordered, exclusive of the street lighting not yet carried out. No arc lamps have yet been erected. The present arrangement of machines suffices for about 1,200 lamps, but as yet are far from being overloaded. Nevertheless, the undertaker proposes the erection of a complete reserve dynamo, with its accessories, for the sake of security.

All the machines, transformers, and other plant have been made by Weiz industrialists and tradesmen, under the supervision of the undertaker, the principal portions being produced at the machinery works and iron foundry of Anton Schlacher's widow, and by the local watchmaker and mechanician, Anton Lang. The latter, in particular, has executed the electrical measuring instruments with surprising precision. They have been carefully calibrated by Dr. Albert von Ettingshausen, professor at the technical high school at Graz, and pronounced very good. The professor has taken altogether the kindest interest in the Weiz electrical works, and has assisted the undertaker with valuable advice.

For lighting the streets in Market Weiz the undertaker offers to erect, attend to, and feed all the street lamps at the very reasonable price of 8 florins per 16-candle glow lamp yearly, and a bonus of 1 florin per 1,000 hours' burning. The community guarantee that the payment for street lighting shall not fall short of 1,000 florins.

It would be desirable if, by mutual agreement, some arc lamps could be set up for lighting streets and open places. It would further be well if the representatives of the community would come to an early decision as to the number and place of the street lamps, so that the entire lighting might be complete by the end of September this year, in view of the 20 years' jubilee of the local volunteer fire brigade, at which many visitors are expected.

The official inspection of the works took place on July 28th and 29th of the current year, when, beyond some unimportant alterations in the water course, no objections were raised against the final opening of the installation. Hence it may be expected that the authorities will, at the earliest possible date, grant the working concession, so that the undertaker may experience a material return for his great sacrifices of trouble, time, and money.

## DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.

IN Prof. Forbes's third lecture, reference is made to Mr. Tesla's discourses on high-pressure and high-frequency alternating currents. And a slight digression is made by the lecturer for the purpose of administering a rebuke to some delinquent technical journal which had had the temerity to ask "What is this to lead to?" a question which would very naturally arise in the minds of practical electricians. Even now, after some months of time for reflection upon Tesla's experiments, there does not seem to be much practical outcome from them—no discovery has been disclosed which might lead to great developments.

The leading facts illustrated and brought home to the audience by a series of novel, brilliant, and striking experiments, have been well known to electricians; the lecture was of value chiefly as an exposition of experimental methods for exhibiting effects and principles usually not shown to advantage by ordinary apparatus hitherto in use. It is very remarkable how stereotyped the teaching of electricity and magnetism in schools and universities has become ever since it, as a science, has been taught. The same old fallacies are perseveringly given and illustrated by the same dear old apparatus so faithfully copied out of one text book into another; consequently, when an experimenter brings forth an entirely new series of experiments to demonstrate well-known facts and principles, working them out by up-to-date machinery and appliances, there is much wonder and astonishment—for a time.

Some of the conclusions drawn from the Tesla lecture are erroneous; for instance, the use of oil as an insulator was known, probably, before the birth of Mr. Tesla, whose experiments did not conclusively prove its value; working with enormous frequency, and with infinitesimally small amounts of energy it answers as an insulator, as shown by Tesla's experiments, but in these experiments there was no power to speak of in the electrical energy employed. The whole current could be taken through the body with safety, simply because there was so little of it. Oil does not close up a break in the insulation of a transformer when there is one or more horse-power behind it, the oil decomposes and carbon is deposited all around the break. Nevertheless, oil has advantages; it decreases the liability to breakdown.

In discussing the transmission and distribution of power from Niagara Falls, and that of the transmission of power in tramways and railways by electricity, the low frequency question crops up again. Undoubtedly, if alternating current motors, excited by alternating currents, are to be used, and if these are rotary current motors with no commutators, or motors with commutators, low frequency would be an advantage for such powers as are required by tramways and railways.

But even with low frequencies—that is, frequency of less than 20 per second—there are troubles with ordinary motors having commutators and laminated field magnets; retardation of phases still affects the working, and if only one single current is used to drive any motor whatever, in which the exciting is alternating, then dead points occur in every period of alternation, and these dead points are a much more serious difficulty at low than at high frequencies, especially in locomotives which have to start from rest with full load on. To get a motor with no dead points two or three-phase currents must be used.

In long electric railway working, high pressure transmission to secondary service conductors, must be adopted. The best that can be done in that case with alternating motors would be with low frequency two-phase motors. We have seen a model of this system, and it certainly looks a good, practicable scheme.

But another system, employing high pressure alternating currents for transmission to secondary generators along the line has been developed recently. These secondary generators transform the high pressure into low, and convert the alternating current into continuous, which is supplied to the secondary service wires. In this case the locomotives are fitted with ordinary continuous current series motors.

As to the utilisation of the power of Niagara, this is such a gigantic affair, that perhaps it would be as well to let every scheme have a trial. There is an old saying that "too many cooks spoil the broth"; the Niagara scheme seems to be attended by too many cooks, and some of them not very competent either. The "utilisation" of Niagara has always been a favourite scheme for the speculative enthusiastic scientist; it has been trotted out annually ever since 1879, and yet it would seem to be too soon yet to set about adopting a scheme. Prof. Forbes says that, "A couple of years ago you would have found that nine out of ten of the experts consulted would have answered that there was nothing but continuous currents could be used," and then he says that now "he doubts whether there would be one out of ten who would say so." Now, if such a sweeping revolution has taken place in the past two years, would it not be judicious on the part of the Niagara Commission to wait for another two years; by about that time nine out of ten of the experts will have been sufficiently educated up to the adoption of multiphase currents and other novelties. The fact of the matter is, that experts can only advise from experience as to "*what has been done before*" by somebody else; if the question is "*what is to be done?*" then it need not be put before experts, one good engineer would solve the problem much more satisfactorily. The "utilisation" of Niagara power will yet remain for some years as an excellent problem for men who can use their heads; attempting its solution is excellent exercise, and not unprofitable if you happen to be an expert.

That any alternator would work reversed as a motor was well known years before the invention of Mordey's alternator. The statement that there is small self-induction in Mordey's armature is not correct; the self-induction is considerable, although there is no iron in the armature coils; they are, at least, one-half of them enclosed by the iron polar faces, and in that position have considerable self-induction.

All the same, there is no doubt that every synchronising motor ought to have a fly-wheel, or its armature should act as such. The difficulty of starting a synchronising motor is altogether passed over, although that has always been its chief drawback. And there is also the little difficulty in exciting synchronising motors, entailing the use of commutators and brushes.

However good these motors may be, it is a fact that there is really not a motor in the market for sale at this moment which any purchaser could put on the existing alternating

current supply circuits, and which would start with load on, and without time and trouble being taken at every start. A synchronising motor with a separate continuous current exciter, and a battery of storage cells, is hardly likely to take the place of a simple continuous current motor, and no supply company, as yet, has commenced to give us multiphase current for multiphase motors.

No system of electrical distribution which does not embrace storage, motive power, and electric lighting, can be considered as the final system at the present moment. Each has its own peculiar advantages and its own special drawbacks. A combination of the systems reviewed in these lectures seems to be likely to be evolved. By such a combined system the advantages of alternating current high pressure transmission can be secured, together with low pressure continuous current distribution suitable for storage and motive power.

## IMPROVEMENTS IN ELECTRIC TRANSFORMERS.

THIS invention of Messrs. Pyke & Harris relates to high tension transformers and other electrical power converters, with liquid insulation, in which a more or less viscous nature, such as heavy petroleum, is employed.

The apparatus is constructed with all, or as much as possible, of the mechanical insulation of a permeable character. The transformer is placed in a container of earthenware, corrugated or provided with external ribs, serving at

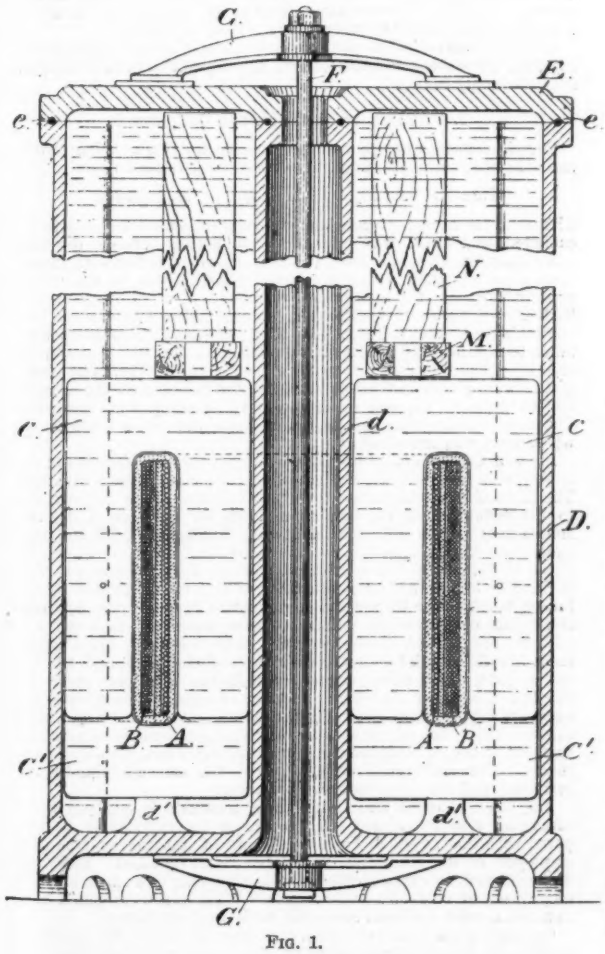



FIG. 1.

the same time as a cooling vessel, the height of which is about three times that of the transformer proper. The transformer consists of concentric coils of wire, arranged so as to form a ring which is arranged in sections, separated from each other by porous insulating material which can be easily penetrated by the insulating liquid. The coils are held together by the iron of the transformer, which is arranged in saddle pieces, placed vertically and radially, so that each set of plates enters one of the corrugations of the vessel. Each horseshoe plate encloses on each side a radial section of the coil. Each set of saddle pieces is applied to the coil alternately from the top and from the bottom, and secured by corner bolts. The transformer has stood a very severe test, and by nature of its disposition, it can be taken

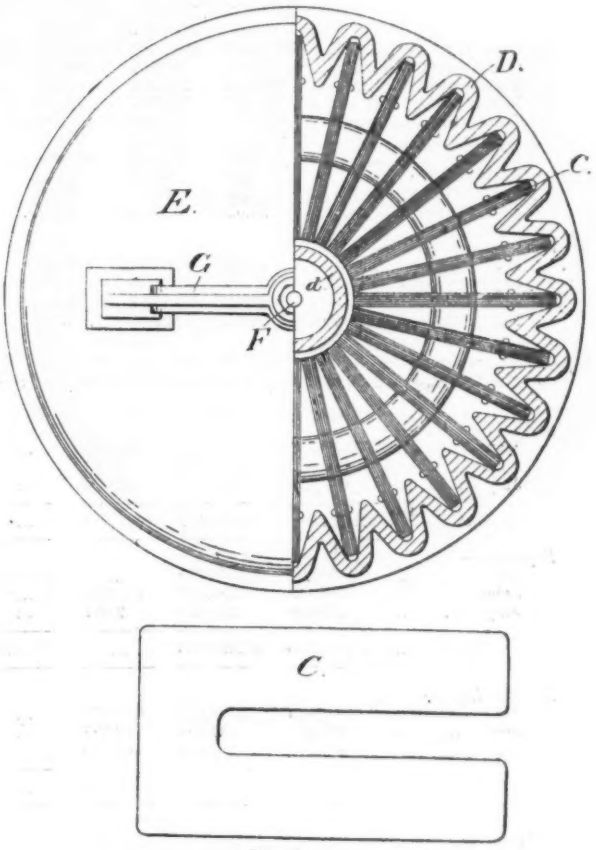



FIG. 2.

apart, new and primary and new secondary coils inserted, and the whole put together again in a very short time.

Fig. 1 is a vertical section, and fig. 2 half horizontal and half plan of the Pyke & Harris transformer. A is the primary, B the secondary coil. C and C' the iron of the transformer. D the earthenware pot serving as a cooling vessel, provided with an axial tube, *d*, reaching up to the top of the vessel. E is the lid, and *e* India-rubber packing rings placed in circular grooves between the vessel and the lid. G, G, are washers connecting the bolts with the vessel and lid. M is an insulating ring placed in the top of the transformer.

## THE COST OF ELECTRIC TRACTION.

THE cost of electric haulage by the overhead system has been stated from time to time as varying between 5 and 10 cents per car mile on American tram-lines. These figures are not exactly comparable with the probable prices in England for the same work; but they are instructive in many ways. Compared with the cost of horse haulage in the American cities, they are in the ratio of 1 : 2; or, in plain language, electricity costs about one-half what horse flesh does. There can be no doubt about this; the figures are not given by enthusiasts or interested parties, but are shown in the balance-sheets of many successful street railways in the United States.

Considering that the Corporation of Glasgow are now

seeking tenders for a system of overhead traction for Glasgow, the balance-sheet of the West-End Street Railway at Boston, now published, has a special value. We append in full the statement of the tramway company, as it will be of interest to many of our readers. It will be noticed that the mileage per month is nearly 1,000,000 car miles, and that the cost of haulage per car mile was 4·56 cents for July, as against 5·06 cents for June. Another important point is that the mileage in July was increased about 14 per cent. over that in June, without an increase in the number of *employés* :—

JULY STATEMENT.

| | Total. | Electric. | Horse. |
|---|---|---|---|
| Gross receipts ... ... | $603,415 | $383,149 | $220,266 |
| General expenses ... | 27,246 | 16,666 | 10,579 |
| Track and car expenses ... | 168,716 | 105,602 | 63,113 |
| Motive power ... ... | 120,811 | 50,777 | 70,033 |
| Total operating expenses | 373,838 | 212,589 | 161,248 |
| Net earnings ... ... | 229,577 | 170,559 | 59,017 |
| Miles run ... ... ... | 1,588,663 | 971,862 | 616,801 |
| Ratio mileage ... ... | 100 | 61.17 | 38.83 |
| Per cent of expenses ... | 61.95 | 55.48 | 73.20 |
| Earnings per mile run ... | 37.98c. | 39·42c. | 35.71c. |
| *Expense per mile run* :— | | | |
| Motive power ... ... | 07.61 | 05.22 | 11.36 |
| Other expenses ... ... | 15.92 | 16.65 | 14.78 |
| Total expenses ... ... | 23.63 | 21.87 | 26.14 |
| Net earnings per mile run | 14.45 | 17.55 | 9.57 |

The following table shows gross and net earnings by months for May, June, and July, compared with last year :—

| | 1892. | 1891. | Inc. | Dec. |
|---|---|---|---|---|
| *Gross Earnings* :— | | | | |
| May ... ... | $540,846 | $521,086 | $19,760 | ... |
| June ... ... | 600,450 | 551,592 | 48,858 | ... |
| July ... ... | 603,415 | 555,739 | 47,673 | ... |
| Total ... | $1,744,711 | $1,628,417 | $116,294 | ... |
| *Expenses* :— | | | | |
| May ... ... | $339,306 | $364,210 | ... | $24,904 |
| June ... ... | 368,416 | 353,135 | $15,281 | ... |
| July ... ... | 373,838 | 366,317 | 7,521 | ... |
| Total ... | $1,081,560 | $1,083,663 | ... | $2,102 |
| *Net Earnings* :— | | | | |
| May ... ... | $201,539 | $156,875 | $44,664 | ... |
| June ... ... | 232,033 | 198,456 | 33,577 | ... |
| July ... ... | 229,577 | 189,422 | 40,155 | ... |
| Total ... | $663,151 | $544,754 | $118,396 | ... |

With such facts before us, it would appear that there is something wrong in the tramway world of Great Britain. No doubt much harm has been done by weak electric companies undertaking this class of work without the necessary knowledge, experience or capital; and we could point to several cases besides the Canning Town-Barking line, where harm rather than good has resulted from the attempted work.

## REVIEWS.

*The Phonograph and How to Construct It.* By W. GILLETT. E. & F. N. Spon, 125, Strand.

The supremacy of the model steam engine as a means for developing the mechanical ingenuity of budding youth seems likely to be disputed in the near future by electrical apparatus. Those who succeed in making a satisfactory working phonograph will have reason to be satisfied with their skill, since they will need not only to give considerable attention to the explicit instructions given by Mr. Gillett, but will have to put in a great deal of exact workmanship as well. The principles of the operation of the instrument are explained in a preliminary chapter with as much success as can be expected in the space devoted to it. The instrument described is a simplified form of Edison's perfected phonograph. The speed wheels, and the varying immersion of the elements of the motor battery, seem to us hardly sufficient substitutes for a governor, though doubtless affording results as good as may be required for amateur purposes.

*La Téléphonie le long des Chemins de fer Belges—a Petite Section.* Par EMILE PIERARD, Ingenieur des Telegraphes a Bruxelles (*Revue Universelles des Mines*), 40, Rue Beckman, Liége. C. Borrain, 9, Rue des Saint-Péres, Paris.

This pamphlet fully describes the application of telephones for signalling purposes on road railways or tramways. M. Piérard says the conditions of the service needed more simple and expeditious apparatus than telegraphs; within the scope of unskilled hands, yet certain in operation, "the telephone alone meets these requirements." The drawbacks of a number of instruments in series, and the advantages of connecting them in "derivation," are shown, and particulars given as to the signals adopted for calling the different stations.

## VOLTAIC CELLS WITH FUSED ELECTROLYTES.*

BY J. BROWN.

(*Abstract.*)

IN comparisons of the observed electromotive forces of voltaic combinations with their theoretical values as given by Thomson's law, the discrepancies frequently observed are probably to a large extent caused by the action of the solvent—usually, of course, water—especially in the cases of easily oxidisable metals, such as magnesium and aluminium.

The solvent may possibly act directly as an electrolyte, or it may act indirectly by the formation of insoluble protective films on the metals. There is also some uncertainty as to how far the heats of solution of the products formed in the cell are adjuvant.

These difficulties led to the consideration of a simpler form of cell in which the solvent is abolished and the liquidity of the electrolyte is produced by fusion.

### I.—CELLS CONTAINING SINGLE CHLORIDES.

Certain chlorides were chosen for the electrolytes as being fusible and otherwise suitable. The cells were of the two-fluid type.

Zinc | $Zn Cl_2$ | $Mg Cl_2$ | Magnesium.

Although the action of atmospheric oxygen cannot be said to be excluded, and there was probably some action between the two chlorides themselves, the results correspond much better with theory than those obtained with the aqueous form of cell. In the actual experiments, one of the chlorides was fused in a V-tube, into one limb of which a short straight tube, plugged below with asbestos, and containing the other chloride, was then inserted. Precautions were taken to mitigate any effects of the mixture of the two electrolytes, and keep the temperature uniform in the cell. The appropriate metals were placed in their chlorides in the tubes, and the electromotive force of the cell so formed was carefully measured on a Thomson electrometer, and compared with that of a Daniell cell, whose force was estimated at 1·13 volt.

A set of experiments were made on all possible combinations of the metals, silver, copper, tin, lead, cadmium and zinc in their chlorides. The theoretical electromotive force was assumed to be proportional to the difference of the combining heats for chlorine of the two metals in any given cell. This difference divided by 50,130 the heat-equivalent of the Daniell, gives the theoretical force of the cell in terms of the Daniell; or the heat equivalent of each metal was first divided by 50,130 and the difference of any two quotients so obtained, taken as the theoretical electromotive force for the cell containing the corresponding metals. On comparing the values so found with the observed electromotive forces, there was fairly good agreement in cells containing any combination of zinc, lead, and tin, but not so good where silver, copper, or cadmium were concerned. It was found, however, that the application of certain corrections to the quotients for each metal as described above, gave theoretical values in much better agreement with the experimental results; so much so, that out of the 15 observed cases, only two differ as much as ·03 from theory. The results are given in two tables, the one containing the uncorrected, and the other the corrected results.

The physical cause underlying these constants is believed to be connected with the higher temperature of the experiment as compared with that at which Thomson's heats of combination (the data employed in the theoretical calculation) were obtained. This view was confirmed by experiments on cells consisting of a single chloride only, fused in a V-tube with a piece of the metal contained in it inserted in each limb and connected with a galvanometer.

On heating one limb more than the other a current was produced in all cases except that of cadmium, the hotter metal being the positive pole. Metal was transferred from the hotter to the cooler pole, showing the electrolytic nature of the phenomenon and suggesting, in the light of Thomson's law, an increase with temperature of the

* Read on June 16th before the Royal Society.

combining heats of the metals with chlorine, conjoined with a possible Peltier effect.

The reversibility of some of the cells was tested by passing currents through them in opposite directions and noting the electromotive force after each current had passed for some minutes. In the combinations, zinc-copper and zinc-lead, there was no evidence of polarisation; with zinc-tin a minute effect, and only in the case of zinc-silver, was there distinct polarisation amounting to about 2·4 per cent. of the whole force of the cell.

II.—CELLS CONTAINING DOUBLE CHLORIDES.

As stated above, it was desirable to test cells in which the easily oxidisable metals, such as magnesium and aluminium, took part. The difficulties of working with the chlorides of these metals in the fused state were got over by employing their compounds with alkaline chlorides, and the same method was adopted with the infusible ferrous chloride. Although the alkaline chloride may here be said to become the solvent of the metallic chloride combined with it, it is assumed that owing to the high combining heat of the alkaline chloride, and the fact that its anion is the same as that of the chloride combined with it (or dissolved in it), no serious complication is introduced by its direct action on the metals, as in the case of water when used as a solvent. The heat of solution of the one chloride in the other must, however, be considered, and in order to avoid as far as possible complications from this source, it was found best that in any given cell the two chlorides employed should be either both double or both single. Experiments were made on cells containing all possible combinations of the metals silver, copper, tin, lead, iron, cadmium, zinc, aluminium, and magnesium in their double alkaline chlorides. The experiments were carried out in the same way as that described for single chlorides, with the result that in the cases of aluminium and magnesium the difference between experiment and theory does not exceed ·2, while in aqueous cells it is found to be from four to five times as great.

The use of a correction for each metal in the way described above produces a still better agreement. After the application of the nine corrections required, the difference in no case out of the thirty-six pairs examined exceeded ·07, which may be considered satisfactory, taking into account the complication introduced by the alkaline chloride. The results for this set are also given in tables.

Since writing the above paper, my attention has been called to a paper by L. Poincarè (*Comptes Rendus*, cx., p. 339), in which there are described some experiments on the thermo-electromotive forces of zinc and tin in their chlorides at unequal temperatures. The force of a Zinc | $Zn\,Cl_2$ | $Sn\,Cl_2$ | Tin cell is also measured, and gives a result very near mine. M. Poincarè considers that in calculating the theoretical values for such cells the heat of fusion of the salts should be considered. It would seem that there may be on theoretical grounds some doubt on this point. Data for deciding it experimentally are not available.

## NEW PATENTS—1892.

15,876. "Improvements in and relating to telephonic instruments." J. MUIRHEAD. Dated September 5th.

15,887. "Improvements in and apparatus for obtaining metals by electrolysis." H. H. FREI. Dated September 5th.

15,959. "Improvements in pneumo-dynamo meters." E. S. D'ODIARDI and E. S. D'ODIARDI. Dated September 6th.

15,960. "Improvements in the means of conveying or administering electricity for medical purposes or others." E. S. D'ODIARDI and E. S. D'ODIARDI. Dated September 6th.

15,961. "Improvements for charging vapours for inhaling purposes or others with electricity." E. S. D'ODIARDI and E. S. D'ODIARDI. Dated September 6th.

15,962. "Improved means for administering electricity to animals or human beings." E. S. D'ODIARDI and E. S. D'ODIARDI. Dated September 6th.

15,963. "Improved means for administering or conveying electricity for medical or other purposes." E. S. D'ODIARDI and E. S. D'ODIARDI. Dated September 6th.

15,969. "Improved electric cork-ribbed belt." G. J. SPEED. Dated September 6th.

15,972. "Improved arrangement of pulleys and bands for driving machines from electro-motors." SIEMENS BROS. & CO., LIMITED. (Communicated by Messrs. Siemens & Halske, Germany.) Dated September 6th.

15,991. "The manufacture and production of compositions of matter suitable for use for bearings, packings, projectile guides or rings, electrical conductors, and analogous articles." P. H. HOLMES. Dated September 6th. (*Complete.*)

15,992. "Improvements in the manufacture of composition bearings, packings, projectile guides or rings, or analogous articles, applicable also for use as electric conductors." P. H. HOLMES. Dated September 6th. (*Complete.*)

15,994. "Improvements in electrical conductors." P. H. HOLMES. Dated September 6th. (*Complete.*)

15,998. "Improvements in the manufacture of electric circuits and cables." A. V. NEWTON. (Communicated by J. A. Barrett, United States.) Dated September 6th. (*Complete.*)

15,999. "Improvements in the manufacture of electrical circuits, cables, and other articles alike subject to flexure." A. V. NEWTON. (Communicated by J. A. Barrett, United States.) Dated September 6th. (*Complete.*)

16,046. "An improved process of and apparatus for the electrolytic decomposition of alkaline salts. H. Y. CASTNER. Dated September 7th.

16,055. "Improvements in dynamo-electric machinery." T. R. FREEMAN and W. W. POPE. Dated September 7th.

16,114. "Improvements in signalling, announcing, and advertising by electric or other light on the clouds or other vapour, and in apparatus therefor." E. CURTICE. Dated September 8th.

16,124. "Improvements relating to telephonic switching apparatus." A. R. BENNETT. Dated September 8th.

16,126. "Improvements in soldering joints of electric wires." W. MOSELEY. Dated September 8th.

16,138. "Improved means for transmitting telegraphic signals through submarine and like cables." H. A. C. SAUNDERS. Dated September 9th.

16,142. "Improvements in telegraphic receiving instruments." J. F. HOFFGAARD. (Communicated by H. P. Fryd, Denmark.) Dated September 9th.

16,154. "A new or improved lubricating inking apparatus for telegraphic purposes." J. F. MILLS. Dated September 9th.

16,176. "Improvements in the means or apparatus for measuring electricity." E. H. P. HUMPHREYS and W. FRIESE-GREENE. Dated September 9th.

16,201. "Improvements in galvanic batteries." J. B. FACHRIS. Dated September 10th.

16,234. "Improvements in coating or plating aluminium with other metals or alloys." G. SELVE. Dated September 10th.

16,246. "Improved process for obtaining aluminium." B. DUKES. (Communicated by J. Rose, Germany.) Dated September 10th.

16,254. "An improvement relating to electrical switches, sockets, cut outs, and like electrical appliances." S. T. WYAND and L. SCHRAMM. Dated September 10th.

16,262. "Improvements in the electrolytical decomposition of alkaline chlorides for the production of chlorine and alkalies, and in apparatus therefor." C. A. FAURE. Dated September 10th.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

*The Price of all Specifications (old and new) is now 8d. each.*

4,235. "Improvements in transmitters for electric step-by-step telegraphs." G. E. FLETCHER. Dated March 10th. Consists essentially of an insulated annulus, divided at one point, within which are a series of radial insulated pieces, one of which is permanently connected to the annulus. Each radial piece, except the one preceding the connected one, is provided with a spring contact maker normally in contact with the succeeding piece and capable of being brought in contact with the annulus. There is also an insulated battery connection provided with a spring contact maker normally in contact with the radial piece immediately succeeding the permanently connected piece and capable of being brought into contact with the annulus. Within the radial pieces is an electro-magnet provided with an oscillating armature which actuates a finger spindle by means of an escapement. The spindle is connected to earth, and by means of a brush to the radial pieces. In front of the apparatus is a dial divided into as many segments as is provided for by the escapement, each segment being marked with the order or signal to be given, and having a perforation through which a key is inserted to bring the desired contact maker in contact with the annulus. When it is desired to send a signal, the key is brought into operation on the segment bearing, the required order or signal and one or more successive electric currents are transmitted according to the distance it is desired that the finger should travel around the dial. By the withdrawal of the key connections are remade so that the finger travels to zero. A step-by-step receiver of any suitable construction is connected to the transmitter by a wire in the usual manner. 1 claim.

4,392. "Improvements in electrical bell and electrical alarm clock apparatus, applicable for use either in combination or separately." W. ENTWISLE. Dated March 11th. Has, for its object, to provide electrical bell and electrical alarm clock apparatus, which may be used either in combination or separately, that is to say, when the electrical alarm clock is disconnected or removed from the electrical bell apparatus, that such clock may be available for use as an ordinary clock, and the electrical bell apparatus available (by connecting it by means of suitable wires to a press button or pusher) for use as an ordinary call-bell, the apparatus being so arranged, that the connecting and disconnecting of the clock and bell apparatus into and out of electrical contact with each other may be readily and rapidly effected. 3 claims.

4,471. "Improvements in electrical switchboards and fuseboards." W. WHITE. Dated March 12th. Claim:—An electrical fuse or switchboard, consisting of a number of bases of non-conducting material arranged side by side, having a main conductor passed transversely through holes in all the bases, and a branch conductor inserted in an end hole of each base, with suitable clamping screws and nuts to hold the fuse or switch-plates, substantially as described.

4,482. "Improvements in and relating to telephonic switchboards." C. J. PRICKETT. Dated March 12th. Has for its object chiefly to provide efficient means whereby a perfect contact is obtained. 4 claims.

12,985. "Improvements in means or apparatus for use in automatic electric railway signalling." R. B. ANNESLEY, J. H. EVANS, and E. BLAKEY. Dated July 31st. A semaphore signal arm is provided, in conjunction with a swinging arm, and is so arranged, as to be operated by the movement of the disc, that is to say, when the electric current acts to remove the disc from the lens, this disc (which is provided with a tail piece) is caused to actuate the semaphore arm, and to place it to the "danger" position. 5 claims.

14,796. "Improvements in electric meters." C. D. ABEL. (Communicated from abroad by La Compagnie Anonyme Continentale pour la Fabrication des Compteurs à Gaz et autres Appareils, of Paris.) Dated September 1st. The current to be measured passes through an electro-dynamometer, and the motor is actuated by a current from any source, such, for example, as a shunt current from the main current. The speed of the motor is regulated by a current regulator controlled by the electro-dynamometer.

15,937. "Improvements in electrical measuring instruments." J. C. FELL. (A communication from abroad by E. Weston, of America.) Dated September 19th. In the annular space between the poles of a permanent magnet is arranged a movable bobbin. The construction of the magnet is such that the space in which the bobbin works, with given magnetism, is magnetic to a high degree, so that the slightest change within such space effected by a current passing through the bobbin effects a change of position in the latter, or, in other words, the bobbin or coil will move into a new position dependent on the strength of the current, in which it will remain, until the strength of current or the resistance is changed. The transmission of the movement of the coil or bobbin to the pointer is arranged so that a small movement of the coil effects a very large movement of the pointer, which is obtained by the pitch of the thread on the pointer spindle. 1 claim.

18,916. "Trollies for electric cars." R. D. NUTTALL. Dated November 3rd. Has for its object, the provision of a novel device, for maintaining contact between a trolley wheel, and an electric conductor with equal certainty on straight and curved sections of the line, and notwithstanding any variations in the height of the conductor above the roadbed, or irregularities in or on the conductor or joints or connections of the same. 4 claims.

20,215. "Improvements relating to electrical machines, and to reversing and interrupting apparatus for use in connection therewith." C. B. HARNESS. Dated November 20th. Relates to electrical or electro-static machines, chiefly designed for medical purposes, and has for its object to provide for automatically reversing or interrupting, at predetermined regular intervals, the flow of the electric fluid between the machine and the patient to be treated.

20,678. "Improvements in electric burglar alarms." F. POHL, jun. Dated November 27th. Consists in an improved apparatus intended to be used in connection with roller blinds or shutters, of all kinds, and with window sashes and doors, and in general with matters or things, by the removal or displacement of which unauthorised persons may enter or obtain access to places which they are not intended to enter or obtain access to. The improved apparatus is intended to cause an electric current to sound an alarm when such shutters, window sashes, doors, &c., are so moved. 1 claim.

20,257. "An improved electric arc lamp." W. P. THOMPSON. (A communication by La Compagnie de l'Industrie Electrique, successor and representative of La Société d'Appareillage Electrique, of Geneva.) Dated December 21st. Has for its object to effect the following:—1. That when the lamp is lighted, should the electric current be intercepted for any cause, the carbons shall not be liable to approach one another. 2. That the space between the carbons determining the length of the arc shall be produced and regulated exclusively by a shunt current, thus allowing several of these lamps to be easily arranged in series. 3. That the mechanism shall be simple, possess as few parts as possible, and only occupy a very little part of the total length of the lamp. Such is of importance when it is a question of lighting a room having a low ceiling, and when the lamp is to be lit for a long time. 4. That the pattern shall be uniform, allowing of lamps being constructed so that they will burn for any length of time without necessitating a change in the gearing, or the altering of the height ($x$ $y$) of the lamp.

## CORRESPONDENCE.

### Harness Interviewed.

In your issue of last week you comment on some notes of an interview which I had with Mr. Harness, the electropathic quack, on December 21st of last year, and which were published in the number of *Science Siftings* which appeared on September 13th. In the course of your remarks you suggest that these notes were based on an article appearing in your paper last month. As a matter of fact they are practically a transcript of notes written down and dated on December 23rd last. Until I read your article, I was under the impression that the fact that these notes referred to an interview which took place last year would be obvious to anyone who took the trouble to read them through.

**G. W. de Tunzelmann.**

*September 17th*, 1892.

### Mesmerism and Hypnotism.

In your issue of September 9th there appeared a leader in reference to the first of a series of papers, by Annie Besant, in the *English Mechanic*.

The spirit which animated the writer appears to have been most friendly albeit somewhat bantering, and in the same friendly tone I would venture, with your kind permission to make a comment or two on his remarks.

Having stated that she (Mrs. Besant) commences with "a review of what has been known of the subject since the days of the pre-Christian Greeks," he goes on to say that "she at once slips into the unpardonable error of confusing the so-called 'magnetism' alleged to exist in the human body with the magnetism that exists in or may be imparted to some forms of inorganic matter. Surely Mrs. Besant does not intentionally patter in the cackle of the charlatan?"

Your leader-writer thus cheerfully commences operations by placing himself on the horns of a dilemma. He either, judging from his style, has absolute proof that there is no such thing as magnetism (such as exists in a bar-magnet) in the human body—or he does not know whether there is or is not. Ignoring the first supposition as highly improbable, let us consider the second: If he does *not* know, he is perfectly entitled to speak of the "*so-called*" magnetism *alleged* to exist in the human body, &c.; but in that case, how in the name of common sense can he presume to pose as a critic on the subject?

His only tenable position, then, is to maintain that the subject is not sufficiently advanced for either him or Mrs. Besant to hold definite ideas about it. Unfortunately for him, even this position, is, to say the least of it, as precarious, and, I take the liberty of saying, an impossible one. If he will be so good as to refer to the *Fortnightly Review*, No. 284, August, 1890, to an article by Dr. J. Luys (Part II.), he will find much confirmation of my position. More might be quoted; and here I might express the opinion that his leader first impelled me to form, viz., how singularly "out of water" a writer on "Economic Electricity" appears, when he comes in contact with that aspect of his own pet force, whose study appertains strictly to the sciences of physiology and psychology.

With respect to his remark, "Surely Mrs. Besant does not intentionally patter in the cackle of the charlatan?" Surely not! What is a charlatan? In the article in the *Fortnightly* just referred to, a well known "charlatan," Reichenbach, has certain of his statemenis absolutely confirmed by the experiments of a living scientist. If "the quotations she gives from some of these worthies might well adorn the circulars of the nineteenth century quacks," so might and do quotations from Shakespeare and other writers of his calibre. I am not aware that it follows from this that either Shakespeare, or the much abused "quack," can necessarily be accused of "charlatanry."

Our friend the "leader-writer" grows positively hysterical, and correspondingly amusing, over the simple and concise statement of Mesmer's theory, which, alas! to him is somehow "not remarkable for its lucidity." He waileth at the end, "As they read this, modern physicists will stand aghast." Oh! If our friend will turn to a fairly simple statement of the modern theory of ether, such as he will find, for example, in "Chamber's Encyclopœdia," latest edition; he will find there, in elementary language, adapted to the meanest intelligence, that that may induce him to seriously reconsider whether "modern physicists will stand aghast."

Finally, I would reiterate my remark a paragraph or so back anent electricity in its physiological and psychic aspects, and would remind him that if there is any truth in Solomon's statement that "there is nothing new under the sun," then the writings of those whom he scornfully dubs "charlatans" may contain much, at least in embryo, that latter-day science is only just beginning to really lay hold of, rapid though her strides have been the last few years.

Thanking you in advance for the insertion of this reply,

**C. H. Collings,**
*Fellow of the Theosophical Society.*

MESMERISM AND HYPNOTISM.—We have received a letter on this subject from a correspondent, signing himself THOS. GEMINI, which is too personal in its references to Mrs. Besant for publication in our columns.